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Forrest G. Hall, Editor

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BOREAS TE-18 Landsat TM Maximum Likelihood Classification Image of the SSA

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BOREAS TE-18 Landsat TM Maximum Likelihood Classification Image of the SSA

Forrest G. Hall, David Knapp

Summary

The BOREAS TE-18 team focused its efforts on using remotely sensed data to characterize the successional and disturbance dynamics of the boreal forest for use in carbon modeling. A Landsat-5 TM image from 06-Aug-1990 was used to derive this classification. The objective of this classification is to provide the BOREAS investigators with a data product that characterizes the land cover of the SSA. A standard supervised maximum likelihood classification approach was used to produce this classification. The data are provided in a binary image format file.

Note that some of the data set files on the BOREAS CD-ROMs have been compressed using the Gzip program. See Section 8.2 for details.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS TE-18 Landsat TM Maximum Likelihood Classification Image of the SSA

1.2 Data Set Introduction

This data set classifies the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA) into 11 land cover classes: wet conifer, dry conifer, mixed, deciduous, fen, water, bare soil/disturbed, recent burn, regeneration (young), regeneration (medium), and regeneration (old). This classification was done using a maximum likelihood classifier with training sites.

1.3 Objective/Purpose

This classification was produced for BOREAS investigators who needed a high spatial resolution land cover data set with which to compare other measurements. For example, one group used it to compare how CO_2 flux varied with land cover along their aircraft flight path.

1.4 Summary of Parameters

Land cover type

The following classes were identified:

Image Value	Class
1	Conifer (Wet)
2	Conifer (Dry)
3	Mixed (Coniferous and Deciduous)
4	Deciduous
5	Fen
6	Water
7	Disturbed
8	Regeneration (Younger)
9	Regeneration (Medium)
10	Regeneration (Older)
11	Visible Burn

1.5 Discussion

The objective of this classification is to provide the BOREAS investigators with a data product that characterizes the land cover of the SSA. These data can be used for modeling purposes. The technique that was used to produce this classification is a standard maximum likelihood supervised classification. Training fields were selected for various land cover types. Statistics were derived from these training sites and subsequently used to classify the image. Specifically, the PCI programs CSG (signature generator) and MLC (multispectral classifier) were used to classify the image.

1.6 Related Data Sets

BOREAS TE-18 Landsat TM Maximum Likelihood Classification Image of the NSA
BOREAS TE-18 Landsat TM Physical Classification Image of the SSA

2. Investigators

2.1 Investigator Name and Title

Dr. Forrest Hall
Biospheric Sciences Branch
National Aeronautics and Space Administration (NASA)
Goddard Space Flight Center (GSFC)

2.2 Title of Investigation

TE-18 Regional Scale Carbon Flux from Modeling and Remote Sensing

2.3 Contact Information

Contact 1:
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(301) 286-0239 (fax)
David.Knapp@gsfc.nasa.gov

3. Theory of Measurements

This product was produced for general use by modelers. The objective of this classification is to provide the BOREAS investigators with a data product that characterizes the land cover of the SSA. The technique that was used to produce this classification is a standard maximum likelihood supervised classification. Training fields were selected for various land cover types. Statistics were derived from these training sites and used to classify the image.

4. Equipment

4.1 Instrument Description

The Landsat-5 Thematic Mapper (TM) sensor system records radiation from the seven bands described in Section 4.2.1. It has a telescope that directs the incoming radiant flux obtained along a scan line through a scan line collector to the visible and near-infrared focal plane, or to the mid-infrared and thermal infrared cooled focal plane. The detectors for the visible and near-infrared bands (1-4) are four staggered linear arrays, each containing 16 silicon detectors. The two mid-infrared detectors are 16 indium-antimonide cells in a staggered linear array, and the thermal-infrared detector is a four-element array of mercury-cadmium-telluride cells.

4.1.1 Collection Environment

The data that were used to produce this classification were collected by the Landsat-5 TM on 06-Aug-1990. Landsat-5 orbits Earth at an altitude of approximately 705 kilometers.

4.1.2 Source/Platform

Landsat-5 satellite

4.1.3 Source/Platform Mission Objectives

The mission of the Landsat-5 satellite is to measure reflected radiation from Earth's surface at a spatial resolution of 30 meters and to measure the temperature of Earth's surface at a spatial resolution of 120 meters.

4.1.4 Key Variables
Reflected radiation
Emitted radiation
Temperature

4.1.5 Principles of Operation
The TM is a scanning optical sensor operating in the visible and infrared wavelengths. It contains a scan mirror assembly that directly projects the reflected Earth radiation onto detectors arrayed in two focal planes. The TM achieves better imagery resolution, sharper color separation, and greater inflight geometric and radiometric accuracy for seven spectral bands simultaneously than the previous Multispectral Scanner (MSS). Data collected by the sensor are transmitted to Earth-receiving stations for processing.

4.1.6 Sensor/Instrument Measurement Geometry
The TM depends on the forward motion of the spacecraft for the along-track scan and uses a moving mirror assembly to scan in the cross-track direction (perpendicular to the spacecraft). The Instantaneous Field of View (IFOV) for each detector from bands 1-5 and band 7 is equivalent to a 30-meter square when projected to the ground; band 6 (the thermal-infrared band) has an IFOV equivalent to a 120-meter square.

4.1.7 Manufacturer of Sensor/Instrument
NASA GSFC
Greenbelt, MD 20771

Hughes Aircraft Corporation
Santa Barbara, CA

4.2 Calibration
The internal calibrator, a flex-pivot-mounted shutter assembly, is synchronized with the scan mirror, oscillating at the same 7-Hz frequency. During the turnaround period of the scan mirror, the shutter introduces the calibration source energy and a black direct-current restoration surface into the 100 detector fields of view.

The calibration signals for bands 1-5 and band 7 are derived from three regulated tungsten-filament lamps. The calibration source for band 6 is a blackbody with three temperature selections, commanded from the ground. The method for transmitting radiation to the moving calibration shutter allows the tungsten lamps to provide radiation independently and to contribute proportionately to the illumination of all detectors.

4.2.1 Specifications
The TM sensor is sensitive to the following spectral bands:

Channel	Wavelength (μm)	Primary Use
1	0.451 - 0.521	Coastal water mapping, soil vegetation differentiation, deciduous/coniferous differentiation.
2	0.526 - 0.615	Green reflectance by healthy vegetation.
3	0.622 - 0.699	Chlorophyll absorption for plant species differentiation.
4	0.771 - 0.905	Biomass surveys, water body delineation.
5	1.564 - 1.790	Vegetation moisture measurement, snow cloud differentiation.
6	10.450 - 12.460	Plant heat stress measurement, other thermal mapping.
7	2.083 - 2.351	Hydrothermal mapping.

Band	Radiometric Sensitivity [NE(dP)]*
1	0.8%
2	0.5%
3	0.5%
4	0.5%
5	1.0%
6	0.5 K [NE(dT)]
7	2.4%

Ground IFOV	30 m (Bands 1-5, 7) 120 m (Band 6)
Avg. altitude	699.6 km
Data rate	85 Mbps
Quantization levels	256
Orbit angle	8.15 degrees
Orbital nodal period	98.88 minutes
Scan width	185 km
Scan angle	14.9 degrees
Image overlap	7.6 %

* N.B. The radiometric sensitivities are the noise-equivalent reflectance differences for the reflective channels expressed as percentages [NE(dP)] and temperature differences for the thermal-infrared bands [NE(dT)].

4.2.1.1 Tolerance

The TM channels were designed for a noise-equivalent differential represented by the radiometric sensitivity shown in Section 4.2.1.

4.2.2 Frequency of Calibration

The absolute radiometric calibration between bands on both sensors is maintained by using internal calibrators that are located between the telescope and the detectors and are sampled at the end of a scan.

4.2.3 Other Calibration Information

Relative within-band radiometric calibration, to reduce "striping," is provided by a scene-based procedure called histogram equalization. The absolute accuracy and relative precision of this calibration scheme assumes that any change in the optics of the primary telescope or the "effective radiance" from the internal calibrator lamps is insignificant in comparison to the changes in detector sensitivity and electronic gain and bias with time and that the scene-dependent sampling is sufficiently precise for the required within-scan destriping from histogram equalization. Each TM reflective band and the internal calibrator lamps were calibrated prior to launch using lamps in integrating spheres that were in turn calibrated against lamps traceable to calibrated National Bureau of Standards lamps. Sometimes the absolute radiometric calibration constants in the "short-term" and "long-term parameters" files used for ground processing have been modified after launch because of inconsistency within or between bands, changes in the inherent dynamic range of the sensors, or a desire to make quantized and calibrated values from one sensor match those from another.

5. Data Acquisition Methods

These data were acquired from the Landsat-5 TM sensor and received from the Canadian Centre for Remote Sensing (CCRS), who purchased them from the Earth Observation Satellite Company (EOSAT). As received from CCRS, the image had been processed from raw telemetry to a systematically corrected product within the CCRS MOSAICS system.

6. Observations

6.1 Data Notes

This imagery was collected on 06-Aug-1990. This scene is Path 37, Row 22-23 (shifted) in the Landsat Worldwide Reference System (WRS). The solar elevation angle at the time of image acquisition was 40.1 degrees. The solar azimuth angle was 146 degrees. The radiometric quality of this imagery was acceptable.

6.2 Field Notes

Not applicable.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The classified image covers an area that is approximately 129 km by 86 km. This includes areas just north of Prince Albert, Saskatchewan. The corner coordinates of the data set are as follows. These coordinates are in the BOREAS Grid projection.

	BOREAS Grid		NAD83	
Corner	X	Y	Longitude	Latitude
Northwest	297.750	393.060	106.40183W	54.44354N
Northeast	435.990	393.060	104.27814W	54.34279N
Southwest	297.750	279.750	106.51441W	53.42864N
Southeast	435.990	279.750	104.44220W	53.33028N

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

Each pixel represents a 30- by 30-meter area on the ground.

7.1.4 Projection

The area mapped is projected in the BOREAS Grid projection, which is based on the ellipsoidal version of the Albers Equal-Area Conic (AEAC) projection. The projection has the following parameters:

```
Datum:  North American Datum of 1983 (NAD83)
Ellipsoid:  Geodetic Reference System of 1980 (GRS80) or Worldwide Geodetic
            System of 1984 (WGS84)

Origin:  53.000°N
Standard Parallels:  52° 30' 00"N
                     54° 30' 00"N

Units of Measure:  Kilometers
```

7.1.5 Grid Description

The data are referenced to the projection described in Section 7.1.4.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

This imagery was collected on 06-Aug-1990. This scene is Path 37, Row 22-23 (shifted) in the Landsat WRS. The solar elevation angle at the time of image acquisition was 47.41 degrees. The solar azimuth angle was 139.83 degrees. The radiometric quality of this imagery was acceptable.

7.2.2 Temporal Coverage Map

Not applicable.

7.2.3 Temporal Resolution

This image was collected at a single point in time and is not multitemporal.

7.3 Data Characteristics

7.3.1 Parameter/Variable

Land cover type.

7.3.2 Variable Description/Definition

In a joint meeting of the Terrestrial Ecology (TE) modelers and the Remote Sensing Science (RSS) algorithm developers in Columbia, MD, July 1992, the following land cover classes were identified as necessary inputs to the TE models. This classification was performed using bands 1-5 and band 7 of a Landsat TM scene acquired on 06-Aug-1990.

Pixel Value	Class Name	Class Description
1	Wet Conifer	Wet Conifer is an area that contains coniferous trees, dominated by black spruce (picea mariana) or jack pine (pinus banksiana) growing on peat or poorly drained mineral soils that have a moss (typically sphagnum moss, sphagnum spp.) in conjunction with a herbaceous background. These areas are "non-dry" and will contain only small amounts of lichen on dry moss hummocks.
2	Dry Conifer	Dry Conifer is an area that contains coniferous trees (primarily jack pine) with a lichen (cladina) background. These areas have sandy soils that are well drained. Areas of permafrost supporting conifers with a lichen background are also included in this class.
3	Mixed Deciduous and Coniferous	Mixed Deciduous and Coniferous contains coniferous and aspen/birch (populus tremuloides/betula papyrifera) trees. The composition of this class contains less than 80% of the dominant species.
4	Deciduous	The Deciduous class contains primarily aspen/birch. The composition of this class is generally greater than 80% deciduous trees.
5	Fen	The Fen/Bog class is characterized by areas with a water table very near or at the surface. Fens experience lateral water transport whereas bogs are enclosed landforms experiencing only vertical transport. Fens typically contain sedges, moss, and bog birch associated with sparse to medium dense tamarack (larix laricina) stands. Bogs are usually treeless.
6	Water	Water bodies such as ponds, lakes, and streams.

7	Disturbed	The Disturbed class consists of areas that are dominated by bare soil, recently logged areas, or rock outcrops. This class also includes roads, airports, and urban areas.
8	Regeneration (Young)	Areas that have been logged or burned. Logging is much more frequent in the Southern Study Area (SSA). These areas have usually been regenerating for 3 or 4 years since disturbance. These areas can contain aspen or jack pine replanted following logging.
9	Regeneration (Medium)	Areas that have been burned or in some cases logged. These areas have typically been regrowing for up to 7 or 8 years since the disturbance. These areas are usually immature aspen or jack pine.
10	Regeneration (Older)	Areas that burned and have been regenerating for about 12 to 20 years. These areas are usually mixed with class 4, indicating that the area is becoming recognizable as deciduous vegetation.
11	Recent Burn	Areas that have been burned in the last 5 or 6 years. Distinguishable for their charred sphagnum background, they are usually areas of very intense burn where little or no vegetation survived.

7.3.3 Unit of Measurement
Land cover type - Coded but unitless value.

7.3.4 Data Source
Landsat-5 TM Scene on 06-Aug-1990 from the CCRS.Forest cover maps of the area were acquired to identify training fields. These forest cover maps were from Forestry Canada and included species composition for various stands. The scale of the maps is 1:12500. These maps were compiled from aerial photography collected in 1984.

7.3.5 Data Range
Land cover type: pixel values of 0 to 11, stored as 8 bit integers.

7.4 Sample Data Record
Not applicable for image data.

8. Data Organization

8.1 Data Granularity
The smallest amount of data that can be ordered from these data is the entire data set.

8.2 Data Format

8.2.1 Uncompressed Data Files
The SSA classification product contains two files as follows:
- File 1: (80-byte American Standard Code for Information Interchange (ASCII) text records) Documentation file
- File 2: (3,777 records of 4,608 bytes each) (1 byte per pixel) Classified image with values from 0 to 11.

8.2.2 Compressed CD-ROM Files

On the BOREAS CD-ROMs, file 1 listed above is stored as ASCII text; however, file 2 has been compressed with the Gzip compression program (file name *.gz). These data have been compressed using gzip version 1.2.4 and the high compression (-9) option (Copyright (C) 1992-1993 Jean-loup Gailly). Gzip (GNU zip) uses the Lempel-Ziv algorithm (Welch, 1994) used in the zip and PKZIP programs. The compressed files may be uncompressed using gzip (-d option) or gunzip. Gzip is available from many Web sites (for example, ftp site prep.ai.mit.edu/pub/gnu/gzip-*.*) for a variety of operating systems in both executable and source code form. Versions of the decompression software for various systems are included on the CD-ROMs.

9. Data Manipulations

9.1 Formulae

No preprocessing of the image data was done before the maximum likelihood classification was performed. The raw digital numbers of the imagery were used as input for the classification.

9.1.1 Derivation Techniques and Algorithms

The PCI programs CSG and MLC were used to create the needed statistics and the classified image. These programs should be referred to for specific calculation formulae.

9.2 Data Processing Sequence

9.2.1 Data Processing Steps

BOREAS Information System (BORIS) staff processed the data by following these steps:

- Selected training fields from the image for various distinct land cover types.
- Reviewed histograms of training fields to check for normality. Revised training fields to correct abnormal cases.
- Generated statistics for training fields using CSG.
- Ran maximum likelihood classifier using MLC.
- Reviewed the classification and combined classes to narrow the number down to 11.
- Wrote the classification image to tape.
- Copied the ASCII and compressed the binary files for release on CD-ROM.

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

None.

9.3.2 Calculated Variables

Refer to PCI programs CSG and MLC for details.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

The sources of error in this classification can be attributed to several factors. In many cases, the spectral signature of one feature could be similar to the spectral signature of another feature, resulting in confusion. The similarity in spectral signatures could be the result of similar background components and variations in tree density. Error could also be a result of spectral mixing of various features that fall within a 30-meter pixel.

10.2 Quality Assessment

10.2.1 Data Validation by Source

The imagery was spot checked at various locations and the image class was compared to the forest cover map. An error assessment was performed on the classification. The BOREAS auxiliary sites were used as ground truth. The location of each auxiliary site was identified on the georeferenced image as a 3- by 3-pixel area. Each of the 9 pixels in these areas represents a test point. Many classes, such as disturbed or water, were not represented by the auxiliary sites.

10.2.2 Confidence Level/Accuracy Judgment

Although efforts have been made to make this classification as accurate as possible, there is bound to be some confusion between classes. In some areas, low productivity wet conifer or fen can be confused with the dry conifer, especially in areas of very young jack pine.

10.2.3 Measurement Error for Parameters and Variables

The following tables and statistics were created:

Accuracy Assessment Confusion Matrix

		Classification								
Class		1	2	3	4	5	6	7	9	10
Truth										
Wet Conifer	(1)	114	3	2	0	2	0	0	1	4
Dry Conifer	(2)	3	18	0	0	2	0	0	1	4
Mixed	(3)	14	0	4	9	0	0	0	0	0
Deciduous	(4)	0	0	0	54	0	0	0	0	0
Fen	(5)	1	0	0	0	0	0	0	0	8
Disturbed	(7)*									
Regen. (Old)	(10)*									

* no auxiliary sites available in this class.

Class	% Correct
Wet Conifer	90.5%
Dry Conifer	66.7%
Mixed	14.8%
Deciduous	100.0%
Fen	0.0%
Overall	78.0%

Kappa = 0.660 or 66.0% better than chance agreement (Campbell, 1987).

10.2.4 Additional Quality Assessments

None.

10.2.5 Data Verification by Data Center

This image was viewed to make sure that it matched the product description and appeared to be a classification image of the BOREAS SSA.

11. Notes

11.1 Limitations of the Data

The user should keep in mind that these data are not 100% accurate. There may be errors or differences in class interpretation that might limit the use of these data for certain applications.

11.2 Known Problems With the Data.

Clouds in this classification show up in the disturbed class, and cloud shadows show up in the water class. These problems are readily apparent when looking at the imagery that was used to create this classification.

11.3 Usage Guidance

Users should be aware of accuracy limitations as well as problems listed in Section 11.2.

Before uncompressing the Gzip files on CD-ROM, be sure that you have enough disk space to hold the uncompressed data files. Then use the appropriate decompression program provided on the CD-ROM for your specific system.

11.4 Other Relevant Information

None.

12. Application of the Data Set

This data set can be used by anyone who wants to get an indication of the distribution of land cover types in the BOREAS SSA. See Section 1.4.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

Various proprietary programs in the EASI/PACE image processing software from PCI, Inc., were used to classify the image. Questions related to the specific details of the software written to process this data set should be addressed to David Knapp (see Section 2.3). Gzip (GNU zip) uses the Lempel-Ziv algorithm (Welch, 1994) used in the zip and PKZIP commands.

14.2 Software Access

EASI/PACE is a proprietary software package developed by PCI, Inc. Contact PCI for details.

PCI, Inc.
50 West Wilmot St.
Richmond Hill
Ontario, Canada L4B 1M5
(905) 764-0614
(905) 764-9604 (fax)

Gzip is available from many Web sites across the Internet (for example, ftp site prep.ai.mit.edu/pub/gnu/gzip-*.*) for a variety of operating systems in both executable and source code form. Versions of the decompression software for various systems are included on the CD-ROMs.

15. Data Access

The SSA maximum likelihood classification data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

These data can be made available on 8-mm, Digital Archive Tape (DAT), or 9-track tapes at 1600 or 6250 Bytes Per Inch (BPI).

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

PACE Image Analysis Kernal Version 5.2. 1993. PCI, Inc. Richmond Hill, Ontario.

Richards, J.A. 1986. Remote Sensing Digital Image Analysis: An Introduction. Springer Verlag.

Welch, T.A. 1984. A Technique for High Performance Data Compression. IEEE Computer, Vol. 17, No. 6, pp. 8-19.

17.2 Journal Articles and Study Reports

Campbell, J.B. 1987. Introduction to Remote Sensing. Guilford Press. p.349.

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

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Sellers, P., F. Hall, and K.F. Huemmrich. 1997. Boreal Ecosystem-Atmosphere Study: 1996 Operations. NASA BOREAS Report (OPS DOC 96).

Sellers, P., F. Hall, H. Margolis, B. Kelly, D. Baldocchi, G. den Hartog, J. Cihlar, M.G. Ryan, B. Goodison, P. Crill, K.J. Ranson, D. Lettenmaier, and D.E. Wickland. 1995. The boreal ecosystem-atmosphere study (BOREAS): an overview and early results from the 1994 field year. Bulletin of the American Meteorological Society. 76(9):1549-1577.

Sellers, P.J., F.G. Hall, R.D. Kelly, A. Black, D. Baldocchi, J. Berry, M. Ryan, K.J. Ranson, P.M. Crill, D.P. Lettenmaier, H. Margolis, J. Cihlar, J. Newcomer, D. Fitzjarrald, P.G. Jarvis, S.T. Gower, D. Halliwell, D. Williams, B. Goodison, D.E. Wickland, and F.E. Guertin. 1997. BOREAS in 1997: Experiment Overview, Scientific Results and Future Directions. Journal of Geophysical Research 102 (D24): 28,731-28,770.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

AEAC	- Albers Equal-Area Conic
ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
BPI	- Bytes per inch
CCRS	- Canadian Centre for Remote Sensing
CD-ROM	- Compact Disk-Read-Only Memory
DAAC	- Distributed Active Archive Center
DAT	- Digital Archive Tape
DEM	- Digital Elevation Model
EOS	- Earth Observing System
EOSAT	- Earth Observing Satellite Company
EOSDIS	- EOS Data and Information System
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GRS80	- Geodetic Reference System of 1980
GSFC	- Goddard Space Flight Center
IFOV	- Instantaneous Field of View
MSA	- Modeling Sub-Area
MSS	- Multispectral Scanner
NAD27	- North American Datum of 1927
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NSA	- Northern Study Area
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
RSS	- Remote Sensing Science
SSA	- Southern Study Area
TE	- Terrestrial Ecology
TM	- Thematic Mapper
URL	- Uniform Resource Locator
UTM	- Universal Transverse Mercator
WGS84	- World Geodetic System of 1984
WRS	- Worldwide Reference System
WWW	- World Wide Web

20. Document Information

20.1 Document Revision Dates

Written: 06-Apr-1995
Last Updated: 01-Mar-1999

20.2 Document Review Dates

BORIS Review: 23-Dec-1997
Science Review:

20.3 Document ID

20.4 Citation

When using these data, please include the following acknowledgment as well as citations of relevant papers in Section 17.2:

These data were classified as a part of investigation TE-18, PI F.G. Hall, using Landsat-5 TM data from 06-Aug-1990. The BOREAS science staff produced this data product. The source of the data was the Canadian Centre for Remote Sensing (CCRS).

If using data from the BOREAS CD-ROM series, also reference the data as:

Dr. Forrest Hall, "TE-18 Regional Scale Carbon Flux from Modeling and Remote Sensing." In Collected Data of The Boreal Ecosystem-Atmosphere Study. Eds. J. Newcomer, D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers. CD-ROM. NASA, 2000.

Also, cite the BOREAS CD-ROM set as:

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM. NASA, 2000.

20.5 Document Curator

20.6 Document URL

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The BOREAS TE-18 team focused its efforts on using remotely sensed data to characterize the successional and disturbance dynamics of the boreal forest for use in carbon modeling. The objective of this classification is to provide the BOREAS investigators with a data product that characterizes the land cover of the SSA. A Landsat-5 TM image from 02-Sep-1994 was used to derive the classification. A technique was implemented that uses reflectances of various land cover types along with a geometric optical canopy model to produce spectral trajectories. These trajectories are used as training data to classify the image into the different land cover classes. These data are provided in a binary image file format.

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