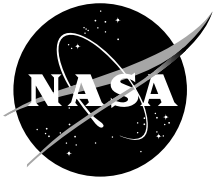


NASA/TM—2000–209891, Vol. 113



**Technical Report Series on the
Boreal Ecosystem-Atmosphere Study (BOREAS)**

Forrest G. Hall, Editor

**Volume 113
BOREAS Forest Cover Data Layers
over the SSA-MSA in Raster Format**

J. Nickeson and F. Gruszka

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

September 2000

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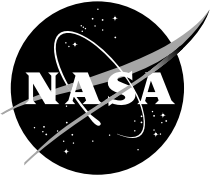
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**BOREAS Forest Cover Data Layers
over the SSA-MSA in Raster Format**

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Prince Albert, SK, Canada*

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BOREAS Forest Cover Data Layers over the SSA-MSA in Raster Format

Jaime Nickeson, Fern Gruszka

Summary

This data set, originally provided as vector polygons with attributes, has been processed by BORIS staff to provide raster files that can be used for modeling or for comparison purposes. The original data were received as ARC/INFO coverages or as export files from SERM. The data include information on forest parameters for the BOREAS SSA-MSA. Most of the data used for this product were acquired by BORIS in 1993; the maps were produced from aerial photography taken as recently as 1988. The data are stored in binary, image format files.

Note that the binary files of this data set 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
- 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

1.1 Data Set Identification

BOREAS Forest Cover Data Layers over the SSA-MSA in Raster Format

1.2 Data Set Introduction

The forest cover data layers were created in raster form from the vector polygon forest cover data provided by Saskatchewan Environment and Resource Management, Forestry Branch - Inventory Unit (SERM-FBIU). The forest cover data layers created for this product are species cover, canopy closure, height, and year.

1.3 Objective/Purpose

These data are provided as part of the BOREal Ecosystem-Atmosphere Study (BOREAS) Staff Science Geographical Information system (GIS) Data Collection Program, which included the collection of pertinent map data in both hardcopy and digital form. This data set, originally provided as vector polygons with attributes, has been processed to provide raster files that can be used for modeling or for comparison purposes.

1.4 Summary of Parameters

The parameters that are in the raster data include species association (cover type), crown closure, height class, and decadal year of stand origin or disturbance.

1.5 Discussion

Based on a review of the data and discussions with SERM personnel and BOREAS scientists, BOREAS Information System (BORIS) staff processed the original vector data into raster data layers. A full description of the data layer derivations is given in Section 9.

1.6 Related Data Sets

BOREAS Forest Cover Data Layers of the NSA-MSA in Raster Format

SERM Forest Cover Data Layers of the SSA in Vector Format

SERM Forest Fire Chronology of Saskatchewan in Vector Format

SERM Forest Cover Data of Saskatchewan in Vector Format

Prince Albert National Park Forest Cover Data in Vector Format

2. Investigator(s)

2.1 Investigator(s) Name and Title

BOREAS Staff Science

2.2 Title of Investigation

BOREAS Staff Science GIS Data Collection Program

2.3 Contact Information

Contact 1:

Fern Gruszka
Saskatchewan Environment and Resource Management
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Prince Albert, SK
CANADA S6V 6G1
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Raytheon ITSS
Code 923
NASA GSFC
Greenbelt, MD 20771
(301) 286-3373
(301) 286-0239 (fax)
Jaime.Nickeson@gsfc.nasa.gov

3. Theory of Measurements

SERM-FBIU maintains in its inventory unit a GIS of forest inventory information for Saskatchewan. This inventory is maintained primarily for use by forest managers for silvicultural purposes, and it contains a wealth of information that can be of use in Earth resources analyses and ecosystem modeling either in its raw form or as a derived product such as this one.

4. Equipment

4.1 Sensor/Instrument Description

The original polygon data were digitized from 1:12,500-scale forest cover maps. The maps were derived from black-and-white 1:12,500-scale infrared aerial photography and field reconnaissance notes. No information is known about the original digitizing equipment or procedures and criteria used in the digitizing process.

4.1.1 Collection Environment

These original vector data were acquired as ARC/INFO vector coverages or in ARC/INFO export format. The data were produced by SERM-FBIU. No specific information other than the scale of the resulting photography is known about the aircraft flights or the equipment that was used to collect the aerial photography.

4.1.2 Source/Platform

Unknown.

4.1.3 Source/Platform Mission Objectives

Unknown.

4.1.4 Key Variables

The key variables of this data set are species cover, crown closure, height class, and decadal year of stand origin or disturbance.

4.1.5 Principles of Operation

Unknown.

4.1.6 Sensor/Instrument Measurement Geometry

Unknown.

4.1.7 Manufacturer of Sensor/Instrument

Unknown.

4.2 Calibration

Unknown.

4.2.1 Specifications

Unknown.

4.2.1.1 Tolerance

Unknown.

4.2.2 Frequency of Calibration

Unknown.

4.2.3 Other Calibration Information

None.

5. Data Acquisition Methods

SERM personnel created the forest cover maps by transcribing information from photo-interpreted 1:12,500-scale black-and-white infrared aerial photography and field reconnaissance notes.

6. Observations

6.1 Data Notes

None.

6.2 Field Notes

The field notes used in compiling the original forest cover data are available from SERM-FBIU. See Section 2.3.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

This data set covers a portion of the BOREAS Southern Study Area (SSA) and encompasses most of the associated SSA-Modeling Sub-Area (MSA). The corners of the actual raster data files are:

Point	BOREAS X (km)	BOREAS Y (km)	West Longitude	North Latitude
Upper Right	425.160	360.840	104.49043	54.06416
Upper Left	381.870	360.840	105.14995	54.09860
Lower Left	381.870	326.490	105.19373	53.79137
Lower Right	425.160	326.490	104.53910	53.75717

These locations represent the outside corners of the corner pixels.

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

These data were gridded to a cell size of 30 m.

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 GRS80 or WGS84
Origin: 111.000° West Longitude
51.000° North Latitude
Standard Parallels: 52° 30' 00" N
58° 30' 00" N
Units of Measure: kilometers

7.1.5 Grid Description

The data are gridded in 30-m intervals based on the ellipsoidal version of the AEAC projection with standard parallels of 52° 30' N and 58° 30' N and a lower left origin of 51° N and 111° W.

7.2 Temporal Characteristics

Most of the data used for this product were acquired by BORIS in 1993. The maps from which the data are derived are completely reinventoried on a 10- to 20-year cycle by SERM, except for disturbed areas, which are updated annually. BORIS acquired the data in 1993; the forest cover layers have not yet had any inventory updates.

7.2.1 Temporal Coverage

These maps were produced from aerial photography taken as recently as 1988. The data base maintained by SERM is updated as needed based on fires, cutting, or other disturbances.

7.2.2 Temporal Coverage Map

Not available.

7.2.3 Temporal Resolution

As noted, the original maps are completely reinventoried by SERM personnel on a 10- to 20-year cycle, except for disturbed areas, which are updated annually. The photographs and other information used to create the original vector data set most likely covered the 10- to 20-year period prior to 1988 and any updates made from then to 1993, when the data were acquired.

7.3 Data Characteristics

7.3.1 Parameter/Variable

Species Association (cover type)
Crown Closure
Height Class
Year of Stand Origin or Disturbance

7.3.2 Variable Description/Definition

- Species Association - The vegetative species association covering the given area as derived by BORIS personnel. See Section 9 for derivation details.
- Crown Closure: The crown closure category specified in the original data set. See Section 9 for derivation details.
- Height Class: The height class of the vegetation covering the area. See Section 9 for class details.
- Year of Stand Origin or Disturbance: The decade in which the vegetation in the area originated or the year it was last disturbed. See Section 9 for coding details.

7.3.3 Unit of Measurement

The values in each of the data layers are described as follows:

SPECIES ASSOCIATION (COVER TYPE)

Binary value	Number in file	Definition
0	317185	border pixels
11	3415	White Spruce (WS)
12	169411	Black Spruce (BS)
13	171532	Jack Pine (JP)
14	10126	Tamarack (TL)
21	202620	Spruce/Pine
31	24728	Mix Spruce Fir/Broadleaf
32	156003	Mix Jack Pine/Broadleaf
51	23902	Mix Broadleaf/Spruce-Fir
52	48546	Mix Broadleaf/Jack Pine
71	12079	Aspen
101	322405	treed muskeg
103	58898	clear muskeg
105	26976	brushland
107	12180	clearing
109	23129	burn-over (nonprod)
112	17638	disturb, cut or burn
113	1100	disturb, JP regeneration
118	30	experimental area
121	959	flooded land
122	49373	water

CROWN CLOSURE (DENSITY)

Binary value	Number in file	definition
0	830069	nonproductive or border pixels
61	11080	10% < CC <= 30%
62	93651	30% < CC <= 55%
63	403725	55% < CC <= 80%
64	313710	80% < CC

HEIGHT CLASS

value	npixels	definition
0	830088	nonproductive or border pixels
5	176609	2.5 m < hgt <= 7.5 m
10	248422	7.5 m < hgt <= 12.5 m
15	310962	12.5 m < hgt <= 17.5 m
20	68612	17.5 m < hgt <= 22.5 m
25	17542	22.5 m < hgt

YEAR OF STAND
ORIGIN or DISTURBANCE

value	npixels	definition
0	811127	nonproductive or border pixels
82	33	1815-1825 Year of stand origin
83	1378	1825-1835
84	2496	1835-1845
85	18158	1845-1855
86	30086	1855-1865
87	12824	1865-1875
88	62706	1875-1885
89	90075	1885-1895
90	104530	1895-1905
91	75163	1905-1915
92	116326	1915-1925
93	30494	1925-1935
94	112734	1935-1945
95	10165	1945-1955
96	2283	1955-1965
97	39688	1965-1975
98	113392	1975-1985
176	103	1976 Year of disturbance
177	51	1977
180	51	1980
183	8	1983
184	7232	1984
185	4951	1985
186	6181	1986

7.3.4 Data Source

The original data were acquired in ARC/INFO format from:

Saskatchewan Environment and Resource Management
Forestry Branch - Inventory Unit
800 Central Ave.
Prince Albert, Saskatchewan
Canada S6V 6G1

The original data were gridded into a binary image format for the SSA-MSA by BORIS personnel.

7.3.5 Data Range

Species Association	0 - 122
Crown Closure	0 - 64
Height Class	0 - 25
Year of Stand Origin or Disturbance	0 - 186

7.4 Sample Data Record

Not applicable.

8. Data Organization

8.1 Data Granularity

The smallest amount of obtainable data is the entire data set containing the four raster layers and other supporting files.

8.2 Data Format(s)

The raster data are stored on tape as single-byte band-sequential binary files.

8.2.1 Uncompressed Data Files

The data files include:

File	Description	Record Size (Bytes)	Number of Records	Bytes/Pixel
1	Header File	80	19	N/A
2	SPECIES COVER	1443	1145	1
3	CROWN CLOSURE	1443	1145	1
4	HEIGHT	1443	1145	1
5	YEAR	1443	1145	1
6	AML 1 (calc cover, year)	80	79	N/A
7	AML 2 (create grid, combine)	80	129	N/A
8	AML 3 (reprojection info)	80	10	N/A

The data set consists of eight files. The first file is the header file, which contains 80-byte records of American Standard Code for Information Interchange (ASCII) characters that describe the general content of the data set.

Files 2 through 5 contain the binary raster data layers. Each raster layer contains 1,443 8-bit (1-byte) values in each of 1,145 lines.

Files 6 through 8 contain ASCII files that provide examples of the type of ARC Macro Language (AML) files used to create this data set from the original vector data. These files were not intended to be used directly; they are merely examples of the process undertaken to produce the provided data set.

8.2.2 Compressed CD-ROM Files

On the BOREAS CD-ROMs, files 1, 6, 7, and 8 listed above are stored as ASCII text files; however, files 2 - 4 have 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

The original data were acquired as ARC/INFO export files, one file per 10-km x 10-km area. The data were imported into ARC, and attributes of the coverage polygons were manipulated within AML scripts to produce new attributes. The new attributes were used as lookup tables for gridding the data, and the separate maps were then mosaicked together into one map for each layer/attribute. The relevant attributes (items) associated with each polygon in the vector data are as follows:

Item	Description
SP10	Primary Species #1 (one of 13 possible tree species)
SP11	Primary Species #2 (same as SP10)
SP12	Primary Species #3 (same as SP10)
SP20	Secondary Species #1 (same as SP10)
HGT	Height Class (one of 5 classes in 5-m intervals)
D	Density (crown closure, see below)
YOO	Decadal Year of Stand Origin
MLEVEL	Management Level (12 rarely used codes for nonforested polygons)
SYR	Year of Source (year source info. for a polygon was obtained)
YSP	Year of Silvicultural Activity (also rarely used)
R1	Regenerating Species 1 (as in SP10, but may not be tree species)
DIST	Disturbance Type (cut-over or partial cut, by season, or burn-over)
DYR	Year of Disturbance
NP	Nonproductive Type (codes to identify all nonforested polygons)

The data layers created for this product were derived from the above attributes as follows:

Raster Layer	Input Vector Items
COVER	SA, SP10, SP11, SP12, SP20, MLEVEL, R1, DIST, NP
CROWN CLOSURE	D
HEIGHT	HGT
YEAR	YOO, YSP, DIST, SA, SYR, DYR NP

9.1.1 Derivation Techniques and Algorithms

The species association data use the items listed above to select one of the 18 species associations as defined by SERM, who provided the data. The minimum size for homogeneous forest stands varies from 1-4 hectares depending upon the size (HGT) and economic value of the species.

The crown closure data were created using the D item within the coverages. This item is the average percent crown closure of the forest stand and is assigned to one of four classes. The boundaries of these classes are given in the table in Section 8.2. Values for item D exist only for forested polygons.

The height class data were created from the HGT item within the coverages. The average height of all living trees in the main canopy of the stand is assigned to one of five height classes. The limits of the height classes are given in Section 8.2. Values for item HGT exist only for forested polygons.

The decadal year of origin or disturbance data were derived from a combination of the items listed above. In the table in Section 8.2, year of silvicultural treatment and year of disturbance are coded similarly. The ages of productive polygons were assigned to decadal classes. When ages overlap two or more classes, the older class is usually chosen. Values for the year-associated items exist only for forested or disturbed polygons.

9.2 Data Processing Sequence

9.2.1 Processing Steps

Most of the following processing steps were performed in ARC/INFO.

- New attribute items were added to the attribute files of each coverage to store the value that would represent cover, crown closure, and year of stand origin
- HGT was already a numeric item and could be used directly as a lookup table for gridding the height layer.
- Crown closure was not numeric, but levels were easily converted to a numeric item that was used to grid the height layer.
- New values were assigned to the new cover item using the SERM definition of species association, which assigns one of 18 common boreal associations from the many possible

combinations of the SP10, SP11, and SP12 (only 10 different species associations show up in this data set).

- Management level, regenerating species, disturbance type, and nonproductive code were used to assign cover values for nonforested polygons.
- To calculate the year item, the year of stand origin item was used for forested polygons, and year of disturbance or source year was used for nonforested polygons.
- The numeric items created for cover and year were then used to grid the polygons for those layers.
- The individual maps that had been gridded were mosaicked using the ARC function GRIDINSERT.
- The resulting Universal Transverse Mercator (UTM) layer maps were reprojected in ARC to create the raster images in the BOREAS grid projection.
- The gridded layers and other information files were written to tape for distribution.
- BORIS staff 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

None.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

There is the possibility of coding errors in the attributes, transcription errors from original sample data, and photo-interpretation errors.

10.2 Quality Assessment

10.2.1 Data Validation by Source

Unknown.

10.2.2 Confidence Level/Accuracy Judgment

The accuracy of the gridding procedure is high. Some consideration should be given to the scale of the data and what will be inferred from it.

10.2.3 Measurement Error for Parameters

Unknown.

10.2.4 Additional Quality Assessments

None.

10.2.5 Data Verification by Data Center

Each gridded image was checked visually to make sure that the gridding procedure assigned a digital number (DN) to each attribute value. The data were also checked for gaps of "no data" along the seams of the 10-km x 10-km coverages used to compile this product.

11. Notes

11.1 Limitations of the Data

BORIS acquired these data in 1993; therefore, areas subjected to logging activity or other disturbance, such as fire, will appear much different today as compared to the forest cover data.

11.2 Known Problems with the Data

None.

11.3 Usage Guidance

Saskatchewan Parks and Renewable Resources does not accept any liability for decisions or action taken on the basis of these data.

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

Saskatchewan Parks and Renewable Resources also maintains stand and stock tables, 3P plots, and possibly some permanent sample plots in this area. Aerial photographic prints and negatives are also available. Contact the agency directly if you are interested in such information or if you wish to acquire those data.

12. Application of the Data Set

This data set would provide good reference information for assessing spectral image data classification techniques over the area and serve as an initial baseline data set for analyzing land cover and vegetation change.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

The Environmental Systems Research Institute (ESRI) ARC/INFO (Version 7.0) package was used to perform the data manipulation and processing. Questions about the software should be directed to ESRI. Gzip (GNU zip) uses the Lempel-Ziv algorithm (Welch, 1994) used in the zip and PKZIP commands.

14.2 Software Access

ARC/INFO is proprietary software with copyright protection. Contact ESRI for details:

Environmental Systems Research Institute, Inc. (ESRI)
380 New York St.
Redlands, CA 92373-8100

Gzip is available from many Web sites across the Internet (for example, ftp site [prep.ai.mit.edu/pub/gnu/gzip-*.*\)](http://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 BOREAS forest cover data layers over the SSA-MSA in raster format 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

None.

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

ARC/INFO User's Guide (Version 7). 1994. Redlands, CA.

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

Lindenau, D.G. June 1985. Forest Inventory Interpretation and Mapping Manual - Specifications for the Interpretation and Mapping of Aerial Photographs in the Forest Inventory Section. Saskatchewan Parks and Renewable Resources

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. 1996. Boreal Ecosystem-Atmosphere Study: 1994 Operations. NASA BOREAS Report (OPS DOC 94).

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
AML	- ARC Macro Language
ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
BS	- Black Spruce
CD-ROM	- Compact Disk - Read-Only Memory
DAAC	- Distributed Active Archive Center
DN	- Digital Number
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
ESRI	- Environmental Systems Research Institute
GIS	- Geographic Information System
GSFC	- Goddard Space Flight Center
JP	- Jack Pine
NASA	- National Aeronautics and Space Administration
NSA	- Northern Study Area
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert National Park
SERM	- Saskatchewan Environment and Resource Management
SSA	- Southern Study Area
TL	- Tamarack
URL	- Uniform Resource Locator
WS	- White Spruce

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