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

Forrest G. Hall and Jaime Nickeson, Editors

Volume 63

BOREAS RSS-14 Level-2 GOES-7 Shortwave and Longwave Radiation Images

J. Gu and E.A. Smith

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

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BOREAS RSS-14 Level-2 GOES-7 Shortwave and Longwave Radiation Images

Jiujing Gu, Eric A. Smith

Summary

The BOREAS RSS-14 team collected and processed several GOES-7 and GOES-8 image data sets that covered the BOREAS study region. This data set contains images of shortwave and longwave radiation at the surface and top of the atmosphere derived from collected GOES-7 data. The data cover the time period of 05-Feb-1994 to 20-Sep-1994. The images missing from the temporal series were zero-filled to create a consistent sequence of files. The data are stored in binary image format files.

Note: due to the large size of the images, the level-1a GOES-7 data are not contained on the BOREAS CD-ROM set. An inventory listing file is supplied on the CD-ROM to inform users of what data were collected. The level-1a GOES-7 image data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC). See sections 15 and 16 for more information.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS RSS-14 Level-2 GOES-7 Shortwave and Longwave Radiation Images

1.2 Data Set Introduction

For the BOReal Ecosystem-Atmosphere Study (BOREAS), the level-2 Geostationary Operational Environmental Satellite 7 (GOES-7) imagery, along with the other remotely sensed images, were collected in order to provide spatially extensive information over the primary study areas at varying spatial scales. These level-2 GOES-7 shortwave and longwave (SW/LW) images acquired and processed by Dr. Eric Smith serve to define the surface radiation budget (SRB) for the BOREAS region.

1.3 Objective/Purpose

The primary objectives are 1) to retrieve the SRB from the level-1 GOES-7 visible images over the BOREAS region at a high temporal and spatial resolution, and 2) to quantify the uncertainties of satellite-derived SRB products.

1.4 Summary of Parameters

The level-2 GOES-7 SW/LW product contains the following parameters:

*Narrow-band albedo at TOA	(0.5 to 0.7 μm)	[0.1 %]
Column water vapor amount		[0.01 cm]
*SW down at TOA	(0.3 to 3.0 μm)	[0.1 W/m^2]
*Narrow-band albedo at TOA	(0.5 to 0.7 μm)	[0.1 %]
Narrow-band cloud albedo	(0.5 to 0.7 μm)	[0.1 %]
Narrow-band minimum albedo	(0.5 to 0.7 μm)	[0.1 %]
SW down at surface	(0.3 to 3.0 μm)	[0.1 W/m^2]
SW up at surface	(0.3 to 3.0 μm)	[0.1 W/m^2]
Surface SW albedo	(0.3 to 3.0 μm)	[0.1 %]
*PAR down	(0.4 to 0.7 μm)	[0.1 W/m^2]
*PAR up	(0.4 to 0.7 μm)	[0.1 W/m^2]
*PAR albedo	(0.4 to 0.7 μm)	[0.1 %]
Net LW at surface	(4.0 to 100.0 μm)	[0.1 W/m^2]

* where TOA is the top of the atmosphere, and PAR is photosynthetically active radiation.

1.5 Discussion

Dr. Eric Smith, from Florida State University (FSU), provided the BOREAS Information System (BORIS) with the level-1 GOES-7 images that were used to create the level-2 products.

1.6 Related Data Sets

BOREAS RSS-14 Level-1 GOES-7 Visible, IR and Water-vapor Images
BOREAS RSS-14 Level-3 Gridded Radiometer and Satellite Radiation Images
BOREAS RSS-14 Level-1 GOES-8 Visible, IR and Water-vapor Images
BOREAS RSS-14 Level-1a GOES-8 Visible, IR and Water-vapor Images

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. Eric A. Smith, Professor

2.2 Title of Investigation

Surface Radiation Budget Retrieved from GOES-7 VISSR Imagery for Large Scale BOREAS Area

2.3 Contact Information

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3. Theory of Measurements

The GOES mission is to provide the nearly continuous, repetitive observations that are needed to predict, detect, and track severe weather. GOES spacecraft are equipped to observe and measure cloud cover, surface conditions, snow and ice cover, surface temperatures, and the vertical distributions of atmospheric temperature and humidity. They are also instrumented to measure solar X-rays and other energetics, collect and relay environmental data from platforms, and broadcast instrument data and environmental information products to ground stations. The GOES system includes the satellite (with the GOES instrumentation and direct downlink data transmission capability); the National Environmental Satellite, Data and Information Service (NESDIS) facility at Wallops Island, VA; and the ground systems at NESDIS.

4. Equipment

4.1 Sensor/Instrument Description

The original GOES instrument was the Visible and Infrared Spin Scan Radiometer (VISSR), which was an outgrowth of the spin-scan radiometer flown aboard several of the Applications Technology Satellite (ATS) series of National Aeronautics and Space Administration (NASA) research satellites. The VISSR was first flown aboard Synchronous Meteorological Satellites (SMS)-1 and -2 used by the National Oceanic and Atmospheric Administration (NOAA). GOES-1, -2, and -3 were operational satellites that flew the original VISSR instrument. GOES-4 through -7 were flown with a modified instrument package called the VISSR Atmospheric Sounder (VAS). A set of infrared sensors was added to provide an atmospheric sounder capability.

The VAS instrument system is an expansion of the VISSR system with improved structural design and some additional capabilities. It consists of the same type of scanning system, a telescope with lighter weight optics made from beryllium instead of conventional materials (glass, steel), eight visible detectors (25 x 24 microradian Instantaneous Field of View (IFOV)), and six infrared detectors.

4.1.1 Collection Environment

The data were acquired using the FSU Direct Readout Ground System located in Tallahassee, FL, starting on 01-Jan-1994 and continuing through July 1995. The GOES-7 satellite orbited Earth in a geostationary orbit at an altitude of 42,000 km.

4.1.2 Source/Platform

Satellite	Launch Date	Data Range
GOES-7	26-Feb-1987	25-Mar-1987 to mid-1995

4.1.3 Source/Platform Mission Objectives

See Sections 1.3 and 3.

4.1.4 Key Variables

The key variables in this data set are:

- surface downward solar and PAR flux
- surface broad-band and narrow-band albedo
- surface net LW flux

4.1.5 Principles of Operation

The VISSR instrument consists of a scanning system, telescope, and infrared and visible sensors. The scanning system consists of a mirror that is stepped mechanically to provide north to south viewing, while the 100-rpm rotation of the GOES satellite provides west to east scanning. The mirror is stepped following each west to east scan. The mirror position is controlled by one of two optical encode wheels attached to the axis. Each step of the mirror causes a change of 192 microradians in the scan angle, representing a distance of 6.9 km near nadir. A sequence of 1,821 scans over 18.21 minutes is performed to provide a "full disk" view from just beyond the northern Earth horizon to just beyond the southern Earth horizon.

The scanning mirror reflects the received radiation into a 16-inch-diameter telescope. A fiber-optics bundle is used to couple the telescope to eight visible detectors (sensitive to the 0.54 to 0.70 micrometer band). The fiber optics bundle is configured such that each of the eight visible sensors has a 20 (W-E) by 25 (N-S) microradian (µrad) FOV on GOES-7. The sensors are arranged in a linear array oriented "north-south" (i.e., perpendicular to the scan direction) thus sweeping out eight parallel scan line paths as the satellite rotates. The FOV provides a ground resolution of 0.9 km (normally referred to as 1 km or 0.5 nautical miles). The system thus provides eight parallel 1 visible data lines per west to east scan, covering the 6.9-km (normally referred to as 8-km or 4-mile) band scanned by each step of the scanning mirror. In addition, germanium relay lenses are used to pass received radiation to two HgCdTe infrared detectors by way of a 10.5 to 12.6 micrometer bandpass filter. The FOV of the infrared detectors is 192 microradians (equal to the north-south scan step angle), and thus the infrared sensors provide equivalent coverage to the eight visible sensors.

The output from the eight visible detectors and from one of the two infrared detectors (or an average of both infrared detectors) is digitized onboard the satellite and transmitted down to Earth in real time. The visible data are sampled every 2 microseconds, which yields visible samples spaced at increments of satellite rotation of 20.9 microradians (assuming a nominal satellite spin rate of 100 rpm), or a near-nadir spacing of 3.0 km. Since the infrared detector FOV is 192 microradians, the infrared data are therefore oversampled in the scan direction. The quantization of the infrared data is 8 bits, and of the visible data 6 bits. The visible scanners are digitized with a square root digitizer for better signal-to-noise ratio. The oversampling of the infrared data leads to their designation as "4 by 2" infrared data (4-mile resolution north-south, 2-mile resolution west-east). The full-resolution scan of all sensors in the mode produces about 226 Mbytes of data per image.

4.1.6 Sensor/Instrument Measurement Geometry

When the VISSR/VAS is installed in the spacecraft, its optical axis becomes parallel to the spacecraft spin axis, which must be parallel to Earth's spin axis. The VAS optical axis is thus perpendicular to the direction of the Earth scene. The optically flat scan mirror of the VAS, placed at a 45-degree angle to the VAS optical axis, directs the Earth scene into the VAS. The spinning is accomplished by stepping the scan mirror from 40 degrees, representing the north polar extreme, to 50 degrees, representing the south polar extreme. An angle position encoder integral with the mirror stepping mechanism converts the position information to electrical signals, which are sent to the Command and Data Acquisition (CDA) station to aid in reassembly of the Earth scene. The 10 degrees of mirror motion (resulting in 20 degrees of optical angle after doubling the optical angle at the mirror) is divided into 1,821 steps, each representing 192 microradians optically.

At the image plane, a relatively large FOV is available. Each detector element is dimensional to define the FOV its signal is intended to represent. For example, the smallest infrared field is 192 microradians defined by a square detector 0.00315 inches on each side. (At synchronous altitude, 192 µrad is equivalent to 5 miles along Earth's surface at the satellite's suborbital point.)

Two focal planes are used in the VAS. Visible spectrum signals are obtained at the principal focus. An optical fiber for each of the eight FOVs defines the field to be measured (25 by 24 microradian) and conveys the impinging light within that FOV to a photomultiplier tube (PMT), which converts the light intensity to a proportional electrical current. Infrared radiation must be sensed by solid state detectors, which are cooled to a low temperature to reduce their intrinsic electrical noise to a level below the electrical equivalent of the least intense radiation to be measured. This cooling is provided by a radiation cooler that radiates excess heat into space. Because of spacecraft design constraints, the cooler must be located away from the prime focal plane. The relay optics provide an appropriate location for an infrared focusing mechanism and filter assembly out of the visible light path. The filter assembly contains a 11.2-centimeter disc, called a filter wheel, that houses 12 spectral pass band filters. During each scan, one filter is placed in the infrared path to acquire data in the desired spectral band. Any one of the filters can be positioned in the infrared optical FOV within 350 milliseconds (i.e., during the time that the VAS telescope is not viewing Earth during a given spin). Filters are inserted in the infrared path only and used in the Multispectral Imaging (MSI) and sounding modes. While 38 channels are possible with the filter wheel detector combinations, only 13 bands can be transmitted.

The scanning schedule and the various modes of operation are uploaded to an electronics module in the satellite. The satellite includes an onboard controller that can itself be reprogrammed via the spacecraft command link.

4.1.7 Manufacturer of Sensor/Instrument

Hughes Santa Barbara Remote Sensing (SBRS) Goleta, CA

4.2 Calibration

The visible channels are calibrated in a vacuum environment at five instrument temperature plateaus. Some adjustments are made to standardize the bit content and start time of the stretched data scans.

Preflight Calibration

- Visible Channel Calibration: The visible channel calibration source is a quartz iodine lamp, the output of which is collimated and spectrally shaped using appropriate optical filters similar to the sun over the spectral band of the visible channels. The output level of the calibration source is established by eight neutral density filters that provide a calibration range from 16% to 100% albedo. The absolute calibration accuracy of the visible channels is estimated to be +/- 10%.
- Thermal Channel Calibration: The visible thermal channels are calibrated at eight target scene temperatures between 180 and 315 K, using a temperature-controlled blackbody source. The estimated absolute calibration accuracy is +/- 1.5 °C, or +/- 1% of full scale, whichever is larger.

In-flight Calibration

- Visible Channels: In-flight calibration of the eight visible PMTs is accomplished by viewing the sun through the complete visible channel optical train via a "side-looking," reduced-aperture collecting prism. The visible channel gains are adjusted in the ground station processing to equalize the eight scanners. This is done to remove stripping of the images. Other gain adjustments are occasionally made for image clarity. Absolute calibrations with the sun viewer are not part of the GOES operating procedure. However, some research programs have produced limited calibrations for parts of the GOES data record.
- Thermal Channel: The in-flight calibration of the visible thermal channel is accomplished by monitoring the temperature of a black-body. This blackbody is activated by command and introduced into the optical path just ahead of the infrared relay optical system. The space view by visible provides an approximately zero signal reference in the thermal bands that is used to establish the zero-end of the measurement scale.

4.2.1 Specifications

```
IFOV
   Visible       25 x 24 microradians
   Infrared     192 x 192 microradians
RESOLUTION (subsatellite)
   Visible      0.9 km
   Infrared     6.9 km
ALTITUDE         35,600 km
GOES SPIN RATE   100 rpm
SCAN RATE        1821 scans/min
SCAN RANGE       approx. 60°N to 60°S
SAMPLES/SCAN     3,822 infrared and 15,288 visible samples per PMT
                 detector per Earth scan
ORBIT POSITION:  0.0°N, 75.0°W
```

4.2.1.1 Tolerance

None given.

4.2.2 Frequency of Calibration

Calibration of the visible and infrared channels is performed after every scan using internal calibrators that are part of the VAS VISSR instrumentation. However, routine calibrations are not made on the visible sensor.

4.2.3 Other Calibration Information

It has been reported by Rossow et al. (1995) that the sensitivities of the VISSR instruments deteriorate at a rate of about 10% per year, and with some short-term variabilities. To account for these sensitivity changes, we have applied the calibration coefficients from International Satellite Cloud Climatology Project (ISCCP) to the GOES-7 visible imagery to convert visible counts to TOA radiances. The ISCCP calibration is available for every month during most of the 1994 Intensive Field Campaigns (IFCs) and Field Focused Campaigns (FFCs). Further information about ISCCP calibration can be found at http://isccp.giss.nasa.gov/calib.html.

5. Data Acquisition Methods

The BOREAS level-2 SW/LW images were created from level-1 GOES-7 visible images. The imagery was obtained by Dr. Eric Smith at FSU and supplied to BORIS. The data were acquired using the FSU Direct Readout Ground System located in Tallahassee, FL, starting on 01-Jan-1994 and continuing through December 1995.

6. Observations

6.1 Data Notes

None given.

6.2 Field Notes

Not applicable.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The scanning system consists of a mirror that is stepped mechanically to provide north to south viewing, while the rotation of the GOES satellite provides west to east scanning. The mirror is stepped following each west to east scan. A sequence of 1,821 scans over 18.21 minutes is performed to provide a "full disk" view from just beyond the northern Earth horizon to just beyond the southern Earth horizon.

Based on the level-1 GOES-7 images, the level-2 SW/LW product covers the entire 1,000-km by 1,000-km BOREAS region. This contains the Southern Study Area (SSA), the Northern Study Area (NSA), the transect region between the SSA and NSA, and some surrounding area.

Based on information contained in the reference latitude and longitude files for the visible band (see Section 8.2), the following North American Datum of 1983 (NAD83) coordinates represent the nominal coverage of the level-2 SW/LW product:

	Latitude	Longitude
Northwest	64.757°N	107.037°W
Northeast	65.911°N	87.120°W
Southwest	47.646°N	109.210°W
Southeast	47.916°N	98.087°W

The NAD83 corner coordinates of the BOREAS region are:

	Latitude	Longitude
Northwest	59.97907°N	111.00000°W
Northeast	58.84379°N	93.50224°W
Southwest	51.00000°N	111.00000°W
Southeast	50.08913°N	96.96951°W

7.1.2 Spatial Coverage Map

Not available at this time.

7.1.3 Spatial Resolution

The GOES-7 SW/LW images have a nominal pixel resolution of 8 x 8 km (approximately 14.2 x 6.6 km at BOREAS latitudes). For details, see Kelly, 1989.

7.1.4 Projection

The BOREAS level-2 SW/LW data are stored in the same GOES 'perfect' projection as the level-1 images. The 'perfect' projection indicates that the satellite movement between temporal acquisitions has been removed so the images are aligned spatially. Detailed information about the projection is not currently available.

7.1.5 Grid Description

Not available at this revision.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage

The SW images provide continuous coverage for the period of 05-Feb to 20-Sep-1994. The LW images cover only the snow-free period from 23-May to 20-Sep-1994.

7.2.2 Temporal Coverage Map

The times when images were acquired varied over the year. The following table gives the times when data are available:

Dates	Times
05-Feb - 14-Feb	16:00 - 21:00 UTC
15-Feb - 14-Mar	15:30 - 22:00 UTC
14-Mar - 11-Apr	14:00 - 23:30 UTC
12-Apr - 02-May	13:00 - 00:30 UTC
03-May - 08-Aug	13:00 - 01:30 UTC
09-Aug - 28-Aug	13:00 - 00:30 UTC
29-Aug - 20-Sep	14:00 - 00:30 UTC

7.2.3 Temporal Resolution

The images were acquired every 30 minutes during the specified time periods of each day.

7.3 Data Characteristics

7.3.1 Parameter/Variable

The parameters contained in the SW/LW data set include:

```
Scaled Narrow-band albedo at TOA
Scaled Column Water vapor amount
Scaled Shortwave Down at TOA
Scaled Narrow-band albedo at TOA
Scaled Narrow-band Cloud albedo
Scaled Narrow-band minimum albedo
Scaled Shortwave down at surface
Scaled Shortwave up at surface
Scaled Surface Shortwave albedo
Scaled PAR down
Scaled PAR up
Scaled PAR albedo
Scaled Net Longwave at surface
```

The parameters contained in the inventory listing file on the CD-ROM are:

```
         Column Name
------------------------------
SPATIAL_COVERAGE
DATE_OBS
START_TIME
END_TIME
PLATFORM
NW_LATITUDE
NW_LONGITUDE
NE_LATITUDE
NE_LONGITUDE
SW_LATITUDE
SW_LONGITUDE
SE_LATITUDE
SE_LONGITUDE
NUM_TIME_PERIODS
NUM_NB_ALBEDO_TOA
NUM_COLUMN_WATER_VAPOR
NUM_DOWN_TOTAL_SW_TOA
NUM_BB_ALBEDO_TOA
NUM_NB_CLOUD_ALBEDO
NUM_MIN_NB_ALBEDO_TOA
NUM_DOWN_TOTAL_SW_SURF
NUM_UP_TOTAL_SW_SURF
NUM_BB_ALBEDO_SURF
NUM_DOWN_PAR_SURF
NUM_UP_PAR_SURF
NUM_PAR_ALBEDO_SURF
NUM_NET_LW_SURF
CRTFCN_CODE
```

7.3.2 Variable Description/Definition

The description of the image band parameters are:

```
Scaled Narrow-band albedo at TOA       (0.5 to 0.7 µm)
Scaled Column Water vapor amount
Scaled Shortwave Down at TOA           (0.3 to 3.0 µm)
Scaled Narrow-band albedo at TOA       (0.5 to 0.7 µm)
Scaled Narrow-band Cloud albedo        (0.5 to 0.7 µm)
Scaled Narrow-band minimum albedo      (0.5 to 0.7 µm)
Scaled Shortwave down at surface       (0.3 to 3.0 µm)
Scaled Shortwave up at surface         (0.3 to 3.0 µm)
Scaled Surface Shortwave albedo        (0.3 to 3.0 µm)
Scaled PAR down                        (0.4 to 0.7 µm)
Scaled PAR up                          (0.4 to 0.7 µm)
Scaled PAR albedo                      (0.4 to 0.7 µm)
Scaled Net Longwave at surface         (4.0 to 100.0 µm)
```

The descriptions of the parameters contained in the inventory listing file on the CD-ROM are:

Column Name	Description
SPATIAL_COVERAGE	The general term used to denote the spatial area over which the data were collected.
DATE_OBS	The date on which the data were collected.
START_TIME	The starting Greenwich Mean Time (GMT) for the data collected.
END_TIME	The ending Greenwich Mean Time (GMT) for the data collected.
PLATFORM	The object (e.g., satellite, aircraft, tower, person) that supported the instrument.
NW_LATITUDE	The NAD83 based latitude coordinate of the north west corner of the minimum bounding rectangle for the data.
NW_LONGITUDE	The NAD83 based longitude coordinate of the northwest corner of the minimum bounding rectangle for the data.
NE_LATITUDE	The NAD83 based latitude coordinate of the north east corner of the minimum bounding rectangle for the data.
NE_LONGITUDE	The NAD83 based longitude coordinate of the northeast corner of the minimum bounding rectangle for the data.
SW_LATITUDE	The NAD83 based latitude coordinate of the south west corner of the minimum bounding rectangle for the data.
SW_LONGITUDE	The NAD83 based longitude coordinate of the southwest corner of the minimum bounding rectangle for the data.
SE_LATITUDE	The NAD83 based latitude coordinate of the south east corner of the minimum bounding rectangle for the data.
SE_LONGITUDE	The NAD83 based longitude coordinate of the southeast corner of the minimum bounding rectangle for the data.
NUM_TIME_PERIODS	The number of 30-minute time periods of data available for the day.
NUM_NB_ALBEDO_TOA	The number of 30-minute time periods during the day when the narrow band (0.5 to 0.7 micrometers) albedo data at the top of the atmosphere are present.
NUM_COLUMN_WATER_VAPOR	The number of 30-minute time periods during the day when the column water vapor data are present.
NUM_DOWN_TOTAL_SW_TOA	The number of 30-minute time periods during the day when the downward total shortwave radiance data at the top of the atmosphere are present.
NUM_BB_ALBEDO_TOA	The number of 30-minute time periods during the day when the broad band (0.3 to 3.0 micrometers) albedo data at the top of the atmosphere are present.
NUM_NB_CLOUD_ALBEDO	The number of 30-minute time periods during the day when the narrow band (0.5 to 0.7 micrometers)

	cloud albedo data are present.
NUM_MIN_NB_ALBEDO_TOA	The number of 30-minute time periods during the day when the minimum narrow band (0.5 to 0.7 micrometers) albedo data at the top of atmosphere are present.
NUM_DOWN_TOTAL_SW_SURF	The number of 30-minute time periods during the day when the downward total shortwave radiance data at the surface are present.
NUM_UP_TOTAL_SW_SURF	The number of 30-minute time periods during the day when the upward total shortwave radiance data at the surface are present.
NUM_BB_ALBEDO_SURF	The number of 30-minute time periods during the day when the broad band (0.3 to 3.0 micrometers) albedo data at the surface are present.
NUM_DOWN_PAR_SURF	The number of 30-minute time periods during the day when the downward PAR (0.4 to 0.7 micrometers) data at the surface are present.
NUM_UP_PAR_SURF	The number of 30-minute time periods during the day when the upward PAR (0.4 to 0.7 micrometers) data at the surface are present.
NUM_PAR_ALBEDO_SURF	The number of 30-minute time periods during the day when the PAR (0.4 to 0.7 micrometers) albedo data at the surface are present.
NUM_NET_LW_SURF	The number of 30-minute time periods during the day when the net longwave radiance data (4.0 to 100.0 micrometers) data at the surface are present.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).

7.3.3 Unit of Measurement

The measurement units for the image parameter files are:

Narrow-band albedo at TOA	[0.1 %]
Column Water vapor amount	[0.01 cm]
Shortwave Down at TOA	[0.1 W/m^2]
Narrow-band albedo at TOA	[0.1 %]
Narrow-band Cloud albedo	[0.1 %]
Narrow-band minimum albedo	[0.1 %]
Shortwave down at surface	[0.1 W/m^2]
Shortwave up at surface	[0.1 W/m^2]
Surface Shortwave albedo	[0.1 %]
PAR down	[0.1 W/m^2]
PAR up	[0.1 W/m^2]
PAR albedo	[0.1 %]
Net Longwave at surface	[0.1 W/m^2]

The measurement units for the parameters contained in the inventory listing file on the CD-ROM are:

Column Name	Units
SPATIAL_COVERAGE	[none]
DATE_OBS	[DD-MON-YY]
START_TIME	[HHMM GMT]
END_TIME	[HHMM GMT]
PLATFORM	[none]
NW_LATITUDE	[degrees]
NW_LONGITUDE	[degrees]
NE_LATITUDE	[degrees]
NE_LONGITUDE	[degrees]
SW_LATITUDE	[degrees]
SW_LONGITUDE	[degrees]
SE_LATITUDE	[degrees]
SE_LONGITUDE	[degrees]
NUM_TIME_PERIODS	[counts]
NUM_NB_ALBEDO_TOA	[counts]
NUM_COLUMN_WATER_VAPOR	[counts]
NUM_DOWN_TOTAL_SW_TOA	[counts]
NUM_BB_ALBEDO_TOA	[counts]
NUM_NB_CLOUD_ALBEDO	[counts]
NUM_MIN_NB_ALBEDO_TOA	[counts]
NUM_DOWN_TOTAL_SW_SURF	[counts]
NUM_UP_TOTAL_SW_SURF	[counts]
NUM_BB_ALBEDO_SURF	[counts]
NUM_DOWN_PAR_SURF	[counts]
NUM_UP_PAR_SURF	[counts]
NUM_PAR_ALBEDO_SURF	[counts]
NUM_NET_LW_SURF	[counts]
CRTFCN_CODE	[none]

7.3.4 Data Source

The level-2 SW/LW images were derived from the level-1 GOES-7 images by Dr. Eric Smith and his staff at Florida State University. The sources of the parameter values contained in the inventory listing file on the CD-ROM are:

Column Name	Data Source
SPATIAL_COVERAGE	[Assigned by BORIS Staff]
DATE_OBS	[RSS14 image header]
START_TIME	[RSS14 image header]
END_TIME	[RSS14 image header]
PLATFORM	[RSS14 image header]
NW_LATITUDE	[RSS14 documentation]
NW_LONGITUDE	[RSS14 documentation]
NE_LATITUDE	[RSS14 documentation]
NE_LONGITUDE	[RSS14 documentation]
SW_LATITUDE	[RSS14 documentation]
SW_LONGITUDE	[RSS14 documentation]
SE_LATITUDE	[RSS14 documentation]
SE_LONGITUDE	[RSS14 documentation]
NUM_TIME_PERIODS	[RSS14 image header]

```
NUM_NB_ALBEDO_TOA              [RSS14 image header]
NUM_COLUMN_WATER_VAPOR         [RSS14 image header]
NUM_DOWN_TOTAL_SW_TOA          [RSS14 image header]
NUM_BB_ALBEDO_TOA              [RSS14 image header]
NUM_NB_CLOUD_ALBEDO            [RSS14 image header]
NUM_MIN_NB_ALBEDO_TOA          [RSS14 image header]
NUM_DOWN_TOTAL_SW_SURF         [RSS14 image header]
NUM_UP_TOTAL_SW_SURF           [RSS14 image header]
NUM_BB_ALBEDO_SURF             [RSS14 image header]
NUM_DOWN_PAR_SURF              [RSS14 image header]
NUM_UP_PAR_SURF                [RSS14 image header]
NUM_PAR_ALBEDO_SURF            [RSS14 image header]
NUM_NET_LW_SURF                [RSS14 image header]
CRTFCN_CODE                    [Assigned by BORIS Staff]
```

7.3.5 Data Range

The maximum range of values in each GOES image band is limited from -16,382 to 16,381 so that the values can be stored in a 2-byte field. The following table gives information about the parameter values found in the inventory table on the CD-ROM.

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SPATIAL_COVERAGE	N/A	N/A	None	None	None	None
DATE_OBS	05-FEB-94	20-SEP-94	None	None	None	None
START_TIME	0	0	None	None	None	None
END_TIME	2330	2330	None	None	None	None
PLATFORM	GOES-7	GOES-7	None	None	None	None
NW_LATITUDE	64.757	64.757	None	None	None	None
NW_LONGITUDE	-107.037	-107.037	None	None	None	None
NE_LATITUDE	65.911	65.911	None	None	None	None
NE_LONGITUDE	-87.12	-87.12	None	None	None	None
SW_LATITUDE	47.646	47.646	None	None	None	None
SW_LONGITUDE	-109.21	-109.21	None	None	None	None
SE_LATITUDE	47.916	47.916	None	None	None	None
SE_LONGITUDE	-98.087	-98.087	None	None	None	None
NUM_TIME_PERIODS	1	26	None	None	None	None
NUM_NB_ALBEDO_TOA	0	26	None	None	None	None
NUM_COLUMN_WATER_VAPOR	0	26	None	None	None	None
NUM_DOWN_TOTAL_SW_TOA	0	26	None	None	None	None
NUM_BB_ALBEDO_TOA	0	26	None	None	None	None
NUM_NB_CLOUD_ALBEDO	0	26	None	None	None	None
NUM_MIN_NB_ALBEDO_TOA	0	26	None	None	None	None
NUM_DOWN_TOTAL_SW_SURF	0	26	None	None	None	None
NUM_UP_TOTAL_SW_SURF	0	26	None	None	None	None
NUM_BB_ALBEDO_SURF	0	26	None	None	None	None
NUM_DOWN_PAR_SURF	0	26	None	None	None	None
NUM_UP_PAR_SURF	0	26	None	None	None	None
NUM_PAR_ALBEDO_SURF	0	26	None	None	None	None

```
NUM_NET_LW_SURF      0              26             None    None   None    None
CRTFCN_CODE          CPI            CPI            None    None   None    None
--------------------------------------------------------------------------------
Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missng Data Value  -- The value that indicates missing data. This is used to
                      indicate that an attempt was made to determine the
                      parameter value, but the attempt was unsuccessful.
Unrel Data Value   -- The value that indicates unreliable data.  This is used
                      to indicate an attempt was made to determine the
                      parameter value, but the value was deemed to be
                      unreliable by the analysis personnel.
Below Detect Limit -- The value that indicates parameter values below the
                      instruments detection limits.  This is used to
                      indicate that an attempt was made to determine the
                      parameter value, but the analysis personnel determined
                      that the parameter value was below the detection
                      limit of the instrumentation.
Data Not Cllctd    -- This value indicates that no attempt was made to
                      determine the parameter value.  This usually
                      indicates that BORIS combined several similar but
                      not identical data sets into the same data base table
                      but this particular science team did not
                      measure that parameter.
Blank -- Indicates that blank spaces are used to denote that type of value.
N/A   -- Indicates that the value is not applicable to the respective column.
None  -- Indicates that no values of that sort were found in the column.
--------------------------------------------------------------------------------
```

7.4 Sample Data Record

A sample data record for the level-2 GOES-7 images is not available here. The following is a sample of the first few records from the data table on the CD-ROM:

```
SPATIAL_COVERAGE,DATE_OBS,START_TIME,END_TIME,PLATFORM,NW_LATITUDE,NW_LONGITUDE,
NE_LATITUDE,NE_LONGITUDE,SW_LATITUDE,SW_LONGITUDE,SE_LATITUDE,SE_LONGITUDE,
NUM_TIME_PERIODS,NUM_NB_ALBEDO_TOA,NUM_COLUMN_WATER_VAPOR,NUM_DOWN_TOTAL_SW_TOA,
NUM_BB_ALBEDO_TOA,NUM_NB_CLOUD_ALBEDO,NUM_MIN_NB_ALBEDO_TO
A,NUM_DOWN_TOTAL_SW_SURF,
NUM_UP_TOTAL_SW_SURF,NUM_BB_ALBEDO_SURF,NUM_DOWN_PAR_SURF,NUM_UP_PAR_SURF,
NUM_PAR_ALBEDO_SURF,NUM_NET_LW_SURF,CRTFCN_CODE
'REGION',05-FEB-94,0,2330,'GOES-7',64.757,-107.037,65.911,-87.12,47.646,-109.21,
47.916,-98.087,10,10,10,10,10,10,10,10,10,10,10,10,10,0,'CPI'
'REGION',06-FEB-94,0,2330,'GOES-7',64.757,-107.037,65.911,-87.12,47.646,-109.21,
47.916,-98.087,11,11,11,11,11,11,11,11,11,11,11,11,11,0,'CPI'
'REGION',07-FEB-94,0,2330,'GOES-7',64.757,-107.037,65.911,-87.12,47.646,-109.21,
 47.916,-98.087,11,11,11,11,11,11,11,11,11,11,11,11,11,0,'CPI'
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data for the level-2 GOES-7 SW/LW imagery is a series of SW or LW images for a given day.

8.2 Data Format(s)

The CD-ROM inventory listing file consists of numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

A complete day of SW and LW data is contained in several SW files and one LW file. The storage format/arrangement of the data is due to the manner in which the SW and LW components were derived and delivered by FSU.

Each SW file contains all the SW parameter images for one 30-minute period. The SW file contains 49 records of 8192 bytes. Each SW parameter image contains 128 2-byte pixel values in each of the 128 lines and is stored in four data file records (i.e., 128 * 2 * 128 = 32,768 and 32,768/4 = 8,192). The series of records in the SW file is:

Record Number	Content	Storage format
01	Header Record	(128 ASCII Characters/Line)
02-05	Scaled Visible Reflectance	(16 bit integers)
06-09	Scaled Water Vapor	(16 bit integers)
10-13	Scaled TOA Down	(16 bit integers)
14-17	Scaled NB TOA Albedo	(16 bit integers)
18-21	Scaled NB Cloud Albedo	(16 bit integers)
22-25	Scaled NB Minimum Albedo	(16 bit integers)
26-29	Scaled SW Down	(16 bit integers)
30-33	Scaled SW Up	(16 bit integers)
34-37	Scaled Surface Albedo	(16 bit integers)
38-41	Scaled PAR Down	(16 bit integers)
42-45	Scaled PAR Up	(16 bit integers)
46-49	Scaled PAR Albedo	(16 bit integers)

Each LW file contains all the LW parameter images delivered for a given day. The LW files contain 105 records of 8,192 bytes each (105 * 8,192 = 860,160 bytes per file), one record (8,192 bytes) for the header, and four records for each of 26 images, equaling a total of 104 records of image data. Each LW parameter image contains 128 2-byte pixel values in each of the 128 lines, stored in four 8,192-byte records (128 samples * 2 bytes * 128 lines = 32,768 bytes, and 32,768/4 = 8192). The series of records in the LW file are:

Record Number	Content	Storage format
01	Header Record	(128 Ascii Characters/Line)
002-005	Image for 1300 UTC	(16 bit integers)
006-009	Image for 1330 UTC	(16 bit integers)
010-013	Image for 1400 UTC	(16 bit integers)
014-017	Image for 1430 UTC	(16 bit integers)
018-021	Image for 1500 UTC	(16 bit integers)
022-025	Image for 1530 UTC	(16 bit integers)
026-029	Image for 1600 UTC	(16 bit integers)
030-033	Image for 1630 UTC	(16 bit integers)
034-037	Image for 1700 UTC	(16 bit integers)
038-041	Image for 1730 UTC	(16 bit integers)

```
042-045       Image for 1800 UTC             (16 bit integers)
046-049       Image for 1830 UTC             (16 bit integers)
050-053       Image for 1900 UTC             (16 bit integers)
054-057       Image for 1930 UTC             (16 bit integers)
058-061       Image for 2000 UTC             (16 bit integers)
062-065       Image for 2030 UTC             (16 bit integers)
066-069       Image for 2100 UTC             (16 bit integers)
070-073       Image for 2130 UTC             (16 bit integers)
074-077       Image for 2200 UTC             (16 bit integers)
078-081       Image for 2230 UTC             (16 bit integers)
082-085       Image for 2300 UTC             (16 bit integers)
086-089       Image for 2330 UTC             (16 bit integers)
090-093       Image for 0000 UTC (next day)  (16 bit integers)
094-097       Image for 0030 UTC (next day)  (16 bit integers)
098-101       Image for 0100 UTC (next day)  (16 bit integers)
102-105       Image for 0130 UTC (next day)  (16 bit integers)
```

9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms

The solar parameters were retrieved from GOES-7 visible images using a physical retrieval algorithm described in Gu and Smith (1997). The algorithm includes parameterization of Rayleigh scattering, water vapor and ozone absorption, aerosol and cloud attenuation, and surface reflection.

The surface net LW flux was obtained from surface downward solar flux and in situ measured near-surface temperature using a statistical algorithm described in Gu et al. (1997). The basic theory behind this approach is that solar radiation provides the primary energy load modulating the fundamental daily cycle of net LW flux. Variation of surface temperature is the response of the surface to the incident solar energy, which affects the net LW flux through its effect on upward LW flux.

9.2 Data Processing Sequence

None given.

9.2.1 Processing Steps

None given.

9.2.2 Processing Changes

None given.

9.3 Calculations

None given.

9.3.1 Special Corrections/Adjustments

None given.

9.3.2 Calculated Variables

None given.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

Potential sources of error include:

- Calibration
- Model parameterization: cloud optical properties, Rayleigh scattering
- Uncertainties in input: column water vapor amount, aerosol optical depth
- Quality of level-1 data

10.2 Quality Assessment

10.2.1 Data Validation by Source

The derived SW and LW images were compared with in situ measurements taken during IFC-2 of 1994 at Automated Meteorological Stations (AMS). See Gu and Smith (1997) and Gu et al. (1997) for details.

10.2.2 Confidence Level/Accuracy Judgment

Compared to the downward solar and PAR data measured at the AMS sites during IFC-2 94, the rms errors (in W/m^2) and relative rms errors in (%) are:

	downward solar	downward PAR
all sky:	77.9 (19.0%)	35.7 (21.4%)
clear:	34.3 (6.49%)	16.6 (7.71%)
partly cloudy:	86.2 (19.3%)	35.6 (19.3%)
overcast/rain:	75.3 (35.8%)	42.5 (48.6%)
heavy smoke:	75.1 (21.1%)	43.8 (32.5%)

The mean differences in W/m^2 (retrieved - AMS measured) are:

	downward solar	downward PAR
all sky:	-6.7	10.9
clear:	-8.2	6.3
partly cloudy:	-11.0	6.6
overcast/rain:	6.1	25.0
heavy smoke:	-1.2	19.8

The relative rms differences between the LW images and the in situ measurements taken at the 10 AMS sites are under 40% of the mean measured net LW flux. Note that the in situ measured net LW fluxes (L*) are calculated from measurements of net radiation (Rn) and net solar radiation (K*) i.e., L* = Rn - K*. Part of the rms differences may be a consequence of differences in leveling between the net pyrradiometers and albedometers mounted on some of the AMS towers (c.f. Gu et al., 1997, for details).

10.2.3 Measurement Error for Parameters

See Section 11.2.

10.2.4 Additional Quality Assessments

None given.

10.2.5 Data Verification by Data Center

BORIS staff has viewed the imagery to verify image sizes, data type, and format.

11. Notes

11.1 Limitations of the Data

See Section 11.2.

11.2 Known Problems with the Data

The SW data overestimate both the broad-band and narrow-band surface albedo. Depending on solar zenith angle and surface type, the broad-band surface albedo is 5-30% larger than the albedometer measurements. This is partly due to the single-scattering assumption made to simplify the calculation of Rayleigh scattering. Adding in multiple scattering may reduce the surface albedo at high and low solar zenith angles by ~ 2 and 5%, respectively.

The LW data values are high biased since we have used the near-surface thermodynamic temperature to replace the radiometric skin temperature. This is because there is only one thermal infrared channel in GOES-7 data, which is not sufficient to derive the radiometric temperature within a certain limit of error. For 1996, we will use the surface radiometric temperature retrieved from the split window of GOES-8 data.

11.3 Usage Guidance

None given.

11.4 Other Relevant Information

None given.

12. Application of the Data Set

These data were derived for the purpose of using the radiation fields for temporal and spatial modeling at regional scales.

13. Future Modifications and Plans

The plans for an improved SW algorithm will include:

- improvement in parameterization for Rayleigh scattering
- surface bidirectional reflectance model developed for BOREAS
- bidirectional reflectance model for clouds

The plans for an improved LW algorithm will include:

- use of GOES-8 split window data to retrieve surface skin temperature
- addition of a nighttime algorithm

14. Software

14.1 Software Description

There are README files and FORTRAN programs at our anonymous ftp site. The FORTRAN programs can be used to read the header, the image, or the lat-lon files.

14.2 Software Access

To get on our anonymous ftp site, type:

```
ftp metsat.met.fsu.edu
username: anonymous
password: your email address
cd boreas
-- for SW parameters: cd V1_products
-- for net LW flux: cd L_net_products
```

15. Data Access

The level-2 GOES-7 images 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

The level-2 GOES-7 SW and LW data can be made available on 8-mm tapes or Digital Archive Tapes (DAT).

16.2 Film Products

None.

16.3 Other Products

Although the inventory is contained on the BOREAS CD-ROM set, the actual GOES-7 images are not. See Section 15 for information about how to obtain the data.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

Bobotek, A., A.S. Hechtman, R.J. Komajoa, and P.G. Woolner. July 1995. GOES I-M System description. MITRE Corporation.

Kelly, K.A. 1989. GOES I-M image navigation and registration and user Earth location. GOES I-M Operational Satellite Conf., Arlington, VA, US. Department of Commerce, NOAA, 154-167.

Rossow, W.B., C.L. Brest, and M. Roiter. 1996. International Satellite Cloud Climatology Project (ISCCP) New Radiance Calibrations. WMO/TD-No. 736. World Meteorological Organization.

Rossow, W.B., C.L. Brest, and M.D. Roiter. 1995. International Satellite Cloud Climatology Project (ISCCP): Update of radiance calibration report. Technical Document, World Climate Research Programme (ICSU and WMO), Geneva, Switzerland, 76 pp.

Rossow, W.B., Y. Desormeaux, C.L. Brest, and A. Walker. 1992. International Satellite Cloud Climatology Project (ISCCP): Radiance calibration report. WMO/Technical Document No. 520, World Climate Research Programme and World Meteorological Organization (ICSU and WMO), Geneva, Switzerland, 104 pp.

17.2 Journal Articles and Study Reports

Gu, J. and E.A. Smith. 1997. High-resolution estimates of total solar and PAR surface fluxes over large-scale BOREAS study area from GOES measurements. Journal of Geophysical Research 102(D24):29,685-29,705.

Gu, J., E.A. Smith, G. Hodges, and H.J. Cooper. 1997. Retrieval of Daytime Surface Net Longwave Flux over BOREAS from GOES Estimates of Surface Solar Flux and Surface Temperature. Submitted to Canadian Journal of Remote Sensing.

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.

Rossow, W.B., C.L. Brest, and M.D. Rotier. 1995. International satellite cloud climatology project (ISCCP): Update of radiance calibration. Technical Document, World Climate Research Program (ICSU and WMO), Geneva, Switzerland, 76 pp.

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

Sellers, P. and F. Hall. 1996. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1996-2.0, NASA BOREAS Report (EXPLAN 96).

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 given.

19. List of Acronyms

```
AOCS   - Attitude and Orbit Control System
ASCII  - American Standard Code for Information Interchange
ATS    - Applications Technology Satellite
BB     - Broad-Band
BOREAS - BOReal Ecosystem-Atmosphere Study
BORIS  - BOREAS Information System
BPI    - Bytes Per Inch
CCT    - Computer Compatible Tape
CDA    - Command and Data Acquisition
CD-ROM - Compact Disk-Read-Only Memory
DAAC   - Distributed Active Archive Center
DAT    - Digital Archive Tape
EOS    - Earth Observing System
EOSDIS - EOS Data and Information System
FFC    - Focused Field Campaign
FOV    - Field of View
FSU    - Florida State University
GIS    - Geographic Information System
GMT    - Greenwich Mean Time
GOES   - Geostationary Operational Environmental Satellite
GSFC   - Goddard Space Flight Center
GVAR   - GOES VARiable
IFC    - Intensive Field Campaign
IFOV   - Instantaneous Field of View
IIFC   - Inter IFC
ISCCP  - International Satellite Cloud Climatology Project
LW     - Longwave
NAD83  - North American Datum of 1983
NASA   - National Aeronautics and Space Administration
NB     - Narrow-Band
NESDIS - National Environmental Satellite, Data and Information Service
NLUT   - Normalization Look-Up Table
```

```
NOAA   - National Oceanic and Atmospheric Administration
N-S    - North-South
NSA    - Northern Study Area
NWS    - National Weather Service
ORNL   - Oak Ridge National Laboratory
PANP   - Prince Albert National Park
PAR    - Photosynthetically Active Radiation
PMT    - Photomultiplier Tube
RSS    - Remote Sensing Science
SBRS   - Santa Barbara Remote Sensing
SMS    - Synchronous Meteorological Satellite
SRB    - Surface Radiation Budget
SSA    - Southern Study Area
SW     - Shortwave
TOA    - Top of the Atmosphere
URL    - Uniform Resource Locator
VAS    - VISSR Atmospheric Sounder
VISSR  - Visible and Infrared Spin-Scan Radiometer
```

20. Document Information

20.1 Document Revision Dates

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20.2 Document Review Dates

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20.4 Citation

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

The SRB data were provided by E.A. Smith and J. Gu of the Department of Meteorology, FSU.

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

Smith, E.A., "Surface Radiation Budget Retrieved from GOES-7 VISSR Imagery for Large Scale BOREAS Area." 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

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13. ABSTRACT *(Maximum 200 words)*

The BOREAS RSS-14 team collected and processed several GOES-7 and GOES-8 image data sets that covered the BOREAS study region. This data set contains images of shortwave and longwave radiation at the surface and top of the atmosphere derived from collected GOES-7 data. The data cover the time period of 05-Feb-1994 to 20-Sep-1994. The images missing from the temporal series were zero-filled to create a consistent sequence of files. The data are stored in binary image format files.

Note: due to the large size of the images, the level-1a GOES-7 data are not contained on the BOREAS CD-ROM set. An inventory listing file is supplied on the CD-ROM to inform users of what data were collected. The level-1a GOES-7 image data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC). See sections 15 and 16 for more information.

14. SUBJECT TERMS
BOREAS, remote sensing science, Goes-7 and -8, shortwave and longwave radiation.

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