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

Forrest G. Hall, Editor

Volume 85
BOREAS Level-0 ER-2 Aerial Photography

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National Aeronautics and Space Administration
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September 2000
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Aerial Photography

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Summary
For BOREAS, the ER-2 and other aerial photography was collected to provide finely detailed and spatially extensive documentation of the condition of the primary study sites. The ER-2 aerial photography consists of color-IR transparencies collected during flights in 1994 and 1996 over the study areas.

Note that the level-0 ER-2 photography is not contained on the BOREAS CD-ROM set. An inventory listing file is supplied on the CD-ROM to inform users of the data that were collected. See Section 15 for information about how to acquire actual photographs.

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 Level-0 ER-2 Aerial Photography

1.2 Data Set Introduction
The BOREal Ecosystem-Atmosphere Study (BOREAS) Staff Science effort covered those activities that were BOREAS community-level activities or required uniform data collection procedures across sites and time. These activities included the acquisition, processing, and archiving of the digital images and aerial photography collected on the National Aeronautics and Space Administration's (NASA's) ER-2 aircraft.

1.3 Objective/Purpose
For BOREAS, the ER-2 aerial photography, along with the other photography, was collected in order to provide finely detailed and spatially extensive documentation of the condition of the primary study sites.
1.4 Summary of Parameters
Level-0 ER-2 aerial photography in color-infrared (IR) was obtained by the onboard camera system during acquisition of digital images on ER-2 flights in early fall of 1993 and during the 1994 and 1996 digital data collection periods.

1.5 Discussion
BORAS Information System (BORIS) staff processed the level-0 ER-2 aerial photography by:
• Reviewing the film on the rolls with the flight logs obtained from NASA Ames Research Center (ARC) to check for discrepancies in numbers of frames and coverage
• Compiling the information into spreadsheets for loading into the online data base
• Loading the spreadsheet information into data base tables
• Cross-checking the photographic information against data collected by other instrument systems on the ER-2 aircraft

1.6 Related Data Sets
BORAS Level-0 AOCI Imagery: Digital Counts in BIL Format
BORAS Level-0 Daedalus TMS Imagery: Digital Counts in BIL Format
BORAS RSS-18 Level-1B AVIRIS Imagery: At-sensor Radiance in BIL Format
BORAS Level-0 C-130 Aerial Photography

2. Investigator(s)

2.1 Investigator(s) Name and Title
BOREAS Staff Science

2.2 Title of Investigation
BOREAS Staff Science Aircraft Data Acquisition Program

2.3 Contact Information

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Jeffrey S. Myers
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jmyers@msmail.arc.nasa.gov

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Raytheon ITSS
Code 923
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Greenbelt, MD 20771
(301) 286-7858
(301) 286-0239 (fax)
Jeffrey.Newcomer@gsfc.nasa.gov
### 3. Theory of Measurements

The NASA Earth Resources Aircraft Program at ARC operates the ER-2 aircraft to acquire data for Earth science research. The aerial photographic cameras used on the ER-2 are equipped with film, lenses, and filters needed to meet various photographic needs. For BOREAS, the aerial photography was obtained to help provide fine spatial resolution information about the various intensive measurement sites.

### 4. Equipment

#### 4.1 Sensor/Instrument Description

##### 4.1.1 Collection Environment

As part of the BOREAS Staff Science data collection effort, the ARC High Altitude Aircraft Branch collected and processed color-IR aerial photography to BOREAS level-0 products. The various camera systems were flown on NASA's ER-2 aircraft during the BOREAS mission (see the BOREAS Experiment Plan for flight pattern details and objectives). Maintenance and operation of the cameras are the responsibility of ARC. The ER-2 Experimenter's Handbook (supplemental) produced by the High Altitude Aircraft Branch at ARC provides a description of the systems, calibration procedures, and format.

##### 4.1.2 Source/Platform

NASA's ER-2 Earth Resources Aircraft.

##### 4.1.3 Source/Platform Mission Objectives

The purpose of the aerial photography was to provide detailed spatial resolution information about the sites over which various digital scanner data were obtained.

##### 4.1.4 Key Variables

Reflected radiation.

##### 4.1.5 Principles of Operation

A Wild-Heerbrug RC-10 metric mapping camera was used, with the shutter intervalometer set to acquire frames with a 60% forward overlap to provide stereo coverage.

##### 4.1.6 Sensor/Instrument Measurement Geometry

The BOREAS ER-2 flight altitudes ranged from 19,000 to 20,000-m Above Ground Level (AGL). Generally, one camera acquired photographs using a 304.89-mm focal-length lens, which resulted in photography at scales ranging from 1:62,000 to 1:65,000. The following are the various lens, film, filter, and exposure combinations used:

<table>
<thead>
<tr>
<th>Camera</th>
<th>Focal Length</th>
<th>Film</th>
<th>Filter</th>
<th>F Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC-10 076</td>
<td>304.89 mm</td>
<td>Aerochrome IR SO-060</td>
<td>Wratten 12</td>
<td>11</td>
</tr>
<tr>
<td>RC-10 034</td>
<td>304.66 mm</td>
<td>Aerochrome IR SO-060</td>
<td>Wratten 12</td>
<td>8</td>
</tr>
</tbody>
</table>

The Wild-Heerbrug RC-10 is a metric mapping camera equipped with a shutter intervalometer set to acquire frames with a 60% forward overlap to provide stereo coverage. The RC-10 film can be used to produce standard photogrammetric products or scanned to generate digital orthophotos.
4.1.7 Manufacturer of Sensor/Instrument
Wild-Heerbrug

4.2 Calibration
The RC-10 cameras are regularly calibrated by the Optical Science Laboratory of the U.S. Geological Survey (USGS) in Reston, VA.

4.2.1 Specifications
The wavelength ranges (in micrometers) of film/filter combinations used are:

<table>
<thead>
<tr>
<th>Film Filter</th>
<th>Effective Wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerochrome IR SO-060</td>
<td>0.510-0.900 mm</td>
</tr>
<tr>
<td>Wratten 12</td>
<td></td>
</tr>
</tbody>
</table>

DESIGN DATA:

<table>
<thead>
<tr>
<th>Camera</th>
<th>F-Stop</th>
<th>Lens focal length</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC-10 076</td>
<td>11</td>
<td>30.489 cm</td>
</tr>
<tr>
<td>RC-10 034</td>
<td>8</td>
<td>30.466 cm</td>
</tr>
</tbody>
</table>

4.2.1.1 Tolerance
None given.

4.2.2 Frequency of Calibration
The RC-10 cameras are regularly calibrated by the Optical Science Laboratory of the USGS in Reston, VA.

4.2.3 Other Calibration Information
None given.
5. Data Acquisition Methods

As part of the BOREAS Staff Science data collection effort, the ARC High Altitude Aircraft Branch collected and processed color-IR aerial photography to BOREAS level-0 products. The various camera systems were flown on NASA's ER-2 aircraft during the BOREAS mission (see the BOREAS Experiment Plan for flight pattern details and objectives). Maintenance and operation of the cameras are the responsibility of ARC. The ER-2 Experimenter's Handbook (supplemental) produced by the High Altitude Aircraft Branch at ARC provides a description of the systems, calibration procedures, and format.

6. Observations

6.1 Data Notes
None.

6.2 Field Notes
Flight summary reports are available.

7. Data Description

7.1 Spatial Characteristics
The BOREAS level-0 photographic images cover portions of the Southern Study Area (SSA) and the Northern Study Area (NSA). A few photographs were acquired for the transect area between the SSA and the NSA. The SSA and the NSA are located in the southwest and northeast portions of the overall BOREAS region.

7.1.1 Spatial Coverage
The North American Datum of 1983 (NAD83) corner coordinates of the SSA are:

<table>
<thead>
<tr>
<th></th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>54.321 N</td>
<td>106.228 W</td>
</tr>
<tr>
<td>Northeast</td>
<td>54.225 N</td>
<td>104.237 W</td>
</tr>
<tr>
<td>Southwest</td>
<td>53.515 N</td>
<td>106.321 W</td>
</tr>
<tr>
<td>Southeast</td>
<td>53.420 N</td>
<td>104.368 W</td>
</tr>
</tbody>
</table>

The NAD83 corner coordinates of the NSA are:

<table>
<thead>
<tr>
<th></th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>56.249 N</td>
<td>98.825 W</td>
</tr>
<tr>
<td>Northeast</td>
<td>56.083 N</td>
<td>97.234 W</td>
</tr>
<tr>
<td>Southwest</td>
<td>55.542 N</td>
<td>99.045 W</td>
</tr>
<tr>
<td>Southeast</td>
<td>55.379 N</td>
<td>97.489 W</td>
</tr>
</tbody>
</table>

7.1.2 Spatial Coverage Map
Not available.
7.1.3 Spatial Resolution
The BOREAS ER-2 flight altitudes ranged from 19,000 to 20,000-m AGL. Generally, one camera acquired photographs using a 304.8-mm focal-length lens, which resulted in photography at scales ranging from 1:62,000 to 1:65,000. The ground resolution is nominally 1.5-4 m.

7.1.4 Projection
Not applicable.

7.1.5 Grid Description
Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
The photographs were collected during BOREAS' Intensive Field Campaigns (IFCs) and the Focused Field Campaign-Thaw (FFC-T), covering the periods of 12-Apr-1994 through 19-Sep-1994 and 07-Mar-1996 and 14-Aug-1996.

7.2.2 Temporal Coverage Map
Not available.

7.2.3 Temporal Resolution
Images were acquired at the following range of dates for each campaign.

<table>
<thead>
<tr>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-Apr-1994 -- 02-May-1994</td>
</tr>
<tr>
<td>19-Jul-1994 -- 08-Aug-1994</td>
</tr>
<tr>
<td>30-Aug-1994 -- 19-Sep-1994</td>
</tr>
<tr>
<td>07-Mar-1996</td>
</tr>
<tr>
<td>14-Aug-1996</td>
</tr>
</tbody>
</table>

7.3 Data Characteristics

7.3.1 Parameter/Variable
The actual photographs are color-IR transparencies. The parameters contained in the inventory listing file on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPATIAL COVERAGE</td>
</tr>
<tr>
<td>DATE_OBS</td>
</tr>
<tr>
<td>START_TIME</td>
</tr>
<tr>
<td>END_TIME</td>
</tr>
<tr>
<td>ER2_START_LATITUDE</td>
</tr>
<tr>
<td>ER2_START_LONGITUDE</td>
</tr>
<tr>
<td>ER2_END_LATITUDE</td>
</tr>
<tr>
<td>ER2_END_LONGITUDE</td>
</tr>
<tr>
<td>ER2_MISSION_ID</td>
</tr>
<tr>
<td>ER2_START_PT</td>
</tr>
<tr>
<td>ER2_END_PT</td>
</tr>
<tr>
<td>PLATFORM_TRACKING</td>
</tr>
<tr>
<td>PLATFORM_ALTITUDE</td>
</tr>
</tbody>
</table>
7.3.2 Variable Description/Definition

The actual photographs are analog pictures captured on transparency film depicting the ground area below the ER-2 aircraft in color-IR. The descriptions of the parameters contained in the inventory listing file on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPATIAL_COVERAGE</td>
<td>The general term used to denote the spatial area over which the data were collected.</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>The date on which the data were collected.</td>
</tr>
<tr>
<td>START_TIME</td>
<td>The starting Greenwich Mean Time (GMT) for the data collected.</td>
</tr>
<tr>
<td>END_TIME</td>
<td>The ending Greenwich Mean Time (GMT) for the data collected.</td>
</tr>
<tr>
<td>ER2_START_LATITUDE</td>
<td>The NAD83 based latitude coordinate at the start of an ER2 flight line as given in the flight summary reports.</td>
</tr>
<tr>
<td>ER2_START_LONGITUDE</td>
<td>The NAD83 based longitude coordinate at the start of an ER2 flight line as given in the flight summary reports.</td>
</tr>
<tr>
<td>ER2_END_LATITUDE</td>
<td>The NAD83 based latitude coordinate at the end of an ER2 flight line as given in the flight summary reports.</td>
</tr>
<tr>
<td>ER2_END_LONGITUDE</td>
<td>The NAD83 based longitude coordinate at the end of an ER2 flight line as given in the flight summary reports.</td>
</tr>
<tr>
<td>ER2_MISSION_ID</td>
<td>The mission identifier assigned to the ER2 mission in the form of YY-DDD where YY is the last two digits of the fiscal year, and DDD is the deployment number. An example would be 94-120.</td>
</tr>
<tr>
<td>ER2_START_PT</td>
<td>The identifier assigned to the starting point of the BOREAS ER2 flight line.</td>
</tr>
<tr>
<td>ER2_END_PT</td>
<td>The identifier assigned to the ending point of the BOREAS ER2 flight line.</td>
</tr>
<tr>
<td>PLATFORM_TRACKING</td>
<td>The azimuthal direction in which the data collection platform was traveling while collecting the data; expressed as degrees clockwise from North.</td>
</tr>
<tr>
<td>PLATFORM_ALTITUDE</td>
<td>The nominal altitude of the data collection platform above the target.</td>
</tr>
<tr>
<td>SENSOR_ID</td>
<td>The identifier given to the sensor/instrument that collected the data.</td>
</tr>
<tr>
<td>FOCAL_LENGTH</td>
<td>The focal length of the lens that was mounted on the camera during the time that the photography was acquired.</td>
</tr>
</tbody>
</table>
FILM_TYPE: The type of photographic film that was used to acquire the imagery. An example is AEROCHROME MS 2448.

START_FRAME_NUM: The starting frame number for this line and run of the flight.

END_FRAME_NUM: The ending frame number for this line and run of the flight.

CLOUDCOVER: The data analyst's assessment of the cloud cover that exists in the data.

PHOTO_QUALITY: The provided or assessed quality of the photograph(s).

COMMENTS: Descriptive information to clarify or enhance the understanding of the other entered data.

### 7.3.3 Unit of Measurement

There is no unit of measurement for the photographs. The measurement units for the parameters contained in the inventory listing file on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPATIAL COVERAGE</td>
<td>[none]</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>[DD-MON-YY]</td>
</tr>
<tr>
<td>START_TIME</td>
<td>[HHMM GMT]</td>
</tr>
<tr>
<td>END_TIME</td>
<td>[HHMM GMT]</td>
</tr>
<tr>
<td>ER2_START_LATITUDE</td>
<td>[degrees]</td>
</tr>
<tr>
<td>ER2_START_LONGITUDE</td>
<td>[degrees]</td>
</tr>
<tr>
<td>ER2_END_LATITUDE</td>
<td>[degrees]</td>
</tr>
<tr>
<td>ER2_END_LONGITUDE</td>
<td>[degrees]</td>
</tr>
<tr>
<td>ER2_MISSION_ID</td>
<td>[none]</td>
</tr>
<tr>
<td>ER2_START_PT</td>
<td>[none]</td>
</tr>
<tr>
<td>ER2_END_PT</td>
<td>[none]</td>
</tr>
<tr>
<td>PLATFORM_TRACKING</td>
<td>[degrees]</td>
</tr>
<tr>
<td>PLATFORM_ALTITUDE</td>
<td>[meters]</td>
</tr>
<tr>
<td>SENSOR_ID</td>
<td>[none]</td>
</tr>
<tr>
<td>FOCAL_LENGTH</td>
<td>[millimeters]</td>
</tr>
<tr>
<td>FILM_TYPE</td>
<td>[none]</td>
</tr>
<tr>
<td>START_FRAME_NUM</td>
<td>[unitless]</td>
</tr>
<tr>
<td>END_FRAME_NUM</td>
<td>[unitless]</td>
</tr>
<tr>
<td>CLOUD_COVER</td>
<td>[none]</td>
</tr>
<tr>
<td>PHOTO_QUALITY</td>
<td>[none]</td>
</tr>
<tr>
<td>COMMENTS</td>
<td>[none]</td>
</tr>
</tbody>
</table>

### 7.3.4 Data Source

NASA ARC Aircraft Data and Sensor Facilities RC-10 aerial mapping cameras are the source of the photography. The source of the parameter values contained in the inventory listing file on the CD-ROM are:

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPATIAL COVERAGE</td>
<td>[Assigned by BORIS staff from spatial information]</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>[Extracted from flight summary report]</td>
</tr>
<tr>
<td>START_TIME</td>
<td>[Extracted from flight summary report]</td>
</tr>
<tr>
<td>END_TIME</td>
<td>[Extracted from flight summary report]</td>
</tr>
<tr>
<td>ER2_START_LATITUDE</td>
<td>[Extracted from flight summary report]</td>
</tr>
</tbody>
</table>
7.3.5 Data Range

There is no data range information for the aerial photographs. The following table gives information about the parameter values found in the inventory table on the CD-ROM.

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Minimum Data Value</th>
<th>Maximum Data Value</th>
<th>Missing Data Value</th>
<th>Unrel Data Value</th>
<th>Below Data Value</th>
<th>Detect Data Value</th>
<th>Not Data Value</th>
<th>Collect Data Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPATIAL COVERAGE</td>
<td>N/A</td>
<td>N/A</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>DATE_OBS</td>
<td>19-APR-94</td>
<td>14-AUG-96</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>START_TIME</td>
<td>1524</td>
<td>2043</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>END_TIME</td>
<td>1528</td>
<td>2045</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>ER2_START_LATITUDE</td>
<td>52.99333</td>
<td>56.12833</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>ER2_END_LATITUDE</td>
<td>43.91667</td>
<td>56.10167</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>ER2_MISSION_ID</td>
<td>94-079</td>
<td>96-161</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>ER2_START_PT</td>
<td>Y</td>
<td></td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>ER2_END_PT</td>
<td>Z</td>
<td></td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>PLATFORM_TRACKING</td>
<td>0</td>
<td>359</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>PLATFORM_ALTITUDE</td>
<td>16762</td>
<td>20147</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>SENSOR_ID</td>
<td>N/A</td>
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<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>FOCAL_LENGTH</td>
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<td>None</td>
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<tr>
<td>FILM_TYPE</td>
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<td>None</td>
<td>None</td>
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<tr>
<td>START_FRAME_NUM</td>
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<td>6846</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
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</tr>
<tr>
<td>END_FRAME_NUM</td>
<td>108</td>
<td>6851</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>CLOUD_COVER</td>
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<td>N/A</td>
<td>None</td>
<td>None</td>
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<td>None</td>
<td>None</td>
<td>Blank</td>
</tr>
<tr>
<td>PHOTO_QUALITY</td>
<td>N/A</td>
<td>N/A</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<tr>
<td>COMMENTS</td>
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<td>N/A</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

Minimum Data Value -- The minimum value found in the column.
Maximum Data Value -- The maximum value found in the column.
Missing 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
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
Sample data records are not applicable to the aerial photographs. The following are wrapped versions of the first few records from the level-0 ER-2 Photography inventory table on the CD-ROM:

```
DATE_OBS,SPATIAL_COVERAGE,START_TIME,END_TIME,ER2_START_LATITUDE,
ER2_START_LONGITUDE,ER2_END_LATITUDE,ER2_END_LONGITUDE,ER2_MISSION_ID,
ER2_START_PT,ER2_END_PT,PLATFORM_TRACKING,PLATFORM_ALTITUDE,SENSOR_ID,
FOCAL_LENGTH,FILM_TYPE,START_FRAME_NUM,END_FRAME_NUM,CLOUD_COVER,PHOTO_QUALITY,
COMMENTS
19-APR-94,'SSA',1801,1804,53.06333,-105.7,53.38333,-105.705,'94-079','A','B',
359.0,19477.0,'RC10-076',304.89,'AEROCHROME IR SO-060',2785,2791,'
' ,'GOOD', 'CLEAR'
19-APR-94,'SSA',1810,1818,53.43167,-106.265,54.31167,-106.265,'94-079','C','D',
0.0,19202.0,'RC10-076',304.89,'AEROCHROME IR SO-060',2792,2809,'
' ,'GOOD', 'CLEAR'
19-APR-94,'SSA',1821,1826,54.09167,-106.0733,53.55833,-106.2433,'94-079','E','F',
191.0,19080.0,'RC10-076',304.89,'AEROCHROME IR SO-060',2810,2820,'
' ,'GOOD', 'CLEAR'
```

8. Data Organization

8.1 Data Granularity
The smallest orderable unit of data for level-0 ER-2 photography is an individual photographic frame. The frames are attached together on a large roll delivered by ARC to BORIS at GSFC.

8.2 Data Format(s)
The 9-inch x 9-inch (229-mm x 229-mm) photographs from single or multiple flight lines are attached together on a large roll delivered by ARC to BORIS at GSFC. Review of the film using a light table is encouraged before ordering copies.

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.
9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms
Standard photographic processing of the original negatives to positive transparencies was performed based on the manufacturer's film developing specifications.

9.2 Data Processing Sequence

9.2.1 Processing Steps
BORIS staff processed the level-0 ER-2 aerial photography by:
- Reviewing the film on the rolls with the flight logs obtained from ARC to check for discrepancies in numbers of frames and coverage
- Compiling the information into spreadsheets for loading into the online data base
- Loading the spreadsheet information into data base tables
- Cross-checking the photographic information against data collected by other data systems on the ER-2 aircraft

9.2.2 Processing Changes
None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments
None.

9.3.2 Calculated Variables
Not applicable.

9.4 Graphs and Plots
None.

10. Errors

10.1 Sources of Error
None given.

10.2 Quality Assessment

10.2.1 Data Validation by Source
Ames and BORIS personnel reviewed the film for overall quality by viewing the resultant photographic images.

10.2.2 Confidence Level/Accuracy Judgment
Confidence is high that the photographs do in fact cover the areas that are indicated in the flight logs and that the film, filter, and lenses shown are the ones that were used.

10.2.3 Measurement Error for Parameters
None.
10.2.4 Additional Quality Assessments
None.

10.2.5 Data Verification by Data Center
BORIS staff processed the level-0 ER-2 aerial photography by:
• Reviewing the film on the rolls with the flight logs obtained from ARC to check for discrepancies in numbers of frames and coverage
• Compiling the information into spreadsheets for loading into the online data base
• Loading the spreadsheet information into data base tables
• Cross-checking the photographic information against data collected by other data systems on the ER-2 aircraft

11. Notes

11.1 Limitations of the Data
To date, no discrepancies or problems have been noted in the film.

11.2 Known Problems with the Data
None.

11.3 Usage Guidance
None.

11.4 Other Relevant Information
None.

12. Application of the Data Set
The photography can be used in conjunction with other digital image data as ground truth for various land cover analyses.

13. Future Modifications and Plans
None.

14. Software

14.1 Software Description
While reviewing the film and flight logs, BORIS personnel compiled information in Excel spreadsheet files for use in loading the online data base. The Excel spreadsheet files were then loaded into the data base with existing Oracle utilities.

14.2 Software Access
Contact Microsoft or Oracle Corporation.
15. Data Access

The level-0 ER-2 aerial photography is 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

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
Not applicable to photographic images.

16.2 Film Products
Color-IR aerial photographs and video records were collected. The video record includes pilot-to-ground conversations and an audible tone that was initiated each time the digital scanner systems were triggered. The BOREAS data base contains an inventory of available BOREAS aircraft flight documentation, such as flight logs and videos.

16.3 Other Products
Although the photograph inventory is contained on the BOREAS CD-ROM set, the actual level-0 ER-2 photographs are not. See Section 15 for information about how to obtain the data.
17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation


17.2 Journal Articles and Study Reports


17.3 Archive/DBMS Usage Documentation
None.

18. Glossary of Terms
None.
19. List of Acronyms

AGL - Above Ground Level
AOCI - Airborne Ocean Color Imager
ARC - Ames Research Center
ASCII - American Standard Code for Information Interchange
AVIRIS - Airborne Visible and Infrared Imaging Spectrometer
BIL - Band Interleaved by Line
BOREAS - BOReal Ecosystem-Atmosphere Study
BORIS - BOREAS Information System
CCT - Computer Compatible Tape
CD-ROM - Compact Disk-Read-Only Memory
DAAC - Distributed Active Archive Center
DAT - Digital Archive Tape
DN - Digital Number
DTMS - Daedalus Thematic Mapper Simulator
EOS - Earth Observing System
EOSDIS - EOS Data and Information System
FFC-T - Focused Field Campaign - Thaw
fPAR - fraction of Photosynthetically Active Radiation
GIS - Geographic Information System
GMT - Greenwich Mean Time
GSFC - Goddard Space Flight Center
IFC - Intensive Field Campaign
IFOV - Instantaneous Field-of-View
I/O - Input/Output
IR - Infrared
LAI - Leaf Area Index
NAD83 - North American Datum of 1983
NASA - National Aeronautics and Space Administration
NIST - National Institute of Standards and Technology
NSA - Northern Study Area
ORNL - Oak Ridge National Laboratory
PANP - Prince Albert National Park
RSS - Remote Sensing Science
SRF - Spectral Response Function
SSA - Southern Study Area
TM - Thematic Mapper
TMS - Thematic Mapper Simulator
\( \mu m \) - micrometers
URL - Uniform Resource Locator
USGS - U.S. Geological Survey

20. Document Information

20.1 Document Revision Dates
Written: 02-Aug-1995
Last Updated: 05-Feb-1999

20.2 Document Review Dates
BORIS Review: 20-May-1997
Science Review: 20-May-1997
20.4 Citation
When using these data, please include the following acknowledgement as well as citations of relevant papers in Section 17.2: The BOREAS level-0 ER-2 photography was collected and processed by personnel at the High Altitude Aircraft Branch at NASA ARC. Their contributions to providing this data set are greatly appreciated.

Also, cite the BOREAS CD-ROM set as:
Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)
BOREAS Level-0 ER-2 Aerial Photography

Jeffrey A. Newcomer and Roseanne Dominguez
Forrest G. Hall, Editor

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National Aeronautics and Space Administration
Washington, DC 20546-0001

J.A. Newcomer: Raytheon ITSS, NASA Goddard Space Flight Center, Greenbelt, Maryland;
R. Dominguez: ATAC, Inc., NASA Ames Research Center, Moffett Field, California

For BOREAS, the ER-2 and other aerial photography was collected to provide finely detailed and
spatially extensive documentation of the condition of the primary study sites. The ER-2 aerial photog-
raphy consists of color-IR transparencies collected during flights in 1994 and 1996 over the study
areas.