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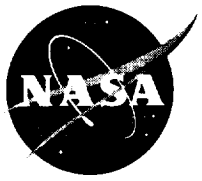

Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Jeffrey A. Newcomer, Editors

Volume 9

BOREAS AFM-5 Level-2 Upper Air Network Standard Pressure Level Data

A. Barr and C. Hrynkiw

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

June 2000

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BOREAS AFM-5 Level-2 Upper-Air Network Standard Pressure Level Data

Alan Barr, Charmaine Hrynkiw

Summary

The BOREAS AFM-5 team collected and processed data from the numerous radiosonde flights during the project. The goals of the AFM-5 team were to provide large-scale definition of the atmosphere by supplementing the existing AES aerological network, both temporally and spatially. This data set includes basic upper-air parameters interpolated at 0.5 kiloPascal increments of atmospheric pressure from data collected from the network of upper-air stations during the 1993, 1994, and 1996 field campaigns over the entire study region. The data are contained in tabular ASCII files.

Table of Contents

1. Data Set Overview

1.1 Data Set Identification

BOREAS AFM-05 Level-2 Upper-Air Network Standard Pressure Level Data

1.2 Data Set Introduction

The BOReal Ecosystem-Atmosphere Study (BOREAS) Aircraft Fluxes and Meteorology (AFM)-05 team oversaw the launch of radiosonde balloons during each Intensive Field Campaign (IFC) in 1993, 1994, and 1996. These launches helped to provide a better understanding of the atmosphere during the data measurement periods.

1.3 Objective/Purpose

The goals of the AFM-05 team were to provide large-scale definition of the atmosphere by supplementing the existing Atmospheric Environment Service (AES) aerological network, both temporally and spatially; provide a large and fine enough mesh to satisfy the spatial requirements of mesoscale modelers; and provide appropriate temporal frequency to resolve diurnally varying atmospheric processes.

1.4 Summary of Parameters

The data include parameters of location, date, time, geopotential height, atmospheric pressure, temperature, dew point temperature, wind direction and speed, u and v components of the wind, potential temperature and equivalent potential temperature, mixing ratio, relative humidity (RH), radiosonde range, radiosonde azimuth angle, radiosonde elevation, and the type of field measured.

1.5 Discussion

The BOREAS upper-air data network operated during the 1993, 1994, and 1996 IFCs. Three proximate sites in the existing AES network (at Saskatoon, SK; The Pas, MB; and Churchill, MB) and two military stations (at Primrose Lake, AB, and Shilo, MB) contributed soundings, augmenting their routine 1200 and 0000 Universal Time Code (UTC) soundings with an additional 1800 (UTC) sounding. A separate National Aeronautics and Space Administration (NASA) activity made a limited number of 1200 UTC soundings at Lynn Lake, MB, during the 1994 IFC-2.

BOREAS augmented the existing network in 1994 with three additional sites at Candle Lake, SK; Key Lake, SK; and Thompson, MB. Soundings were made routinely at 1200, 1800, and 0000 (UTC), and additionally at 1400, 1600, 2000, and 2200 (UTC) on fair-weather days in IFCs 1 to 3 at Candle Lake and Thompson.

The Shilo data (collected in 1994) are not included in the BOREAS Information System (BORIS) data set because of their very coarse resolution and Shilo's distance from the area.

In 1996, routine soundings were performed at 1200 and 0000 (UTC) daily at three existing upper-air sites near the BOREAS study areas (Saskatoon, The Pas, and Churchill). BOREAS augmented the existing network in 1996 with upper-air sites at Candle Lake and Thompson where soundings were typically performed at 1200, 1600, 1800, 2000, 2200, and 0000 (UTC) on fair-weather days and at 1200, 1800, and 0000 (UTC) on poor-weather days.

1.6 Related Data Sets

BOREAS AFM-05 Level-1 Upper-Air Network Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

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National Hydrology Research Center

Alan Betts
Atmospheric Research

2.2 Title of Investigation

Upper-air Network (AFM-05) Boundary Layer Research For BOREAS (AFM-08)

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3. Theory of Measurements

Pressure, temperature, humidity, and wind measurements were converted from radiosonde signals received and processed by an upper-air receiver. The measurements were interpolated at 0.5 kiloPascal (kPa) increments for easier use by researchers.

Wind observations utilized radio-navigation. Wind speed and direction were determined by navigation networks (NAVAID) or via a radiotheodolite positioned near the release site. The NAVAID signals were relayed to the ground station for processing and wind vector computation. The radiotheodolite received signals from the radiosonde and recorded azimuth, elevation, and altitude, from which the trajectory of the radiosonde was calculated.

Depending on the system, higher level processing was conducted after the pressure, temperature, humidity, and radiosonde position signals were converted (i.e., Vaisala).

4. Equipment

4.1 Sensor/Instrument Description

Vaisala (Candle Lake, Key Lake, Thompson, and Churchill)
Radiosonde Type: Vaisala RS80 Series Description

VIZ W9000 (Saskatoon, Lynn Lake, The Pas - 1996)
Radiosonde Type: VIZ-BEUKERS LO-CATE MICROSONDE

Atmospheric Instrumentation Research, Inc. (A.I.R.)
Radiosonde Type: A.I.R.

Aerological Data REduction System (ADRES), The Pas - 1994
Radiosonde Type: 1680-MHz radiosonde

Candle Lake Surface Observation Instruments
Temperature: mercury thermometer
Humidity: wet bulb mercury thermometer
Pressure: Druck digital
Wind Direction and Speed: estimated
Sling psychrometer (1996)
Anemometer (1996)
Aneroid barometer (1996)

Thompson Surface Observation Instruments
Temperature: mercury thermometer
Humidity: wet bulb mercury thermometer
Pressure: Setra 270
Wind Direction and Speed: U2A
Sling psychrometer (1996) was used to measure surface temperature and humidity.
Anemometer (1996)
Setra pressure transducer (1996)

Key Lake and Churchill Surface Observation Instruments
Temperature: thermistor
Humidity: lithium chloride dew cell
Pressure: Setra
Wind Direction and Speed: 78D

The Pas Surface Observation Instruments
Temperature: thermistor
Humidity: lithium chloride dew cell
Pressure: standard mercury barometer
Wind Direction and Speed: U2A

Saskatoon Surface Observation Instruments and Method
Temperature: mercury thermometer (sling psychrometer)
Humidity: wet bulb mercury thermometer (sling psychrometer)
Pressure: Ruska digital barometer
Wind Direction and Speed: U2A

Primrose Lake Surface Observation Instruments and Method
Temperature: mercury thermometer (ventilated Stevenson Screen)
Humidity: wet bulb mercury thermometer (ventilated Stevenson Screen)
Pressure: Ruska digital barometer
Wind Direction and Speed: U2A

4.1.1 Collection Environment
Upper-air data were collected in varying ambient weather conditions.

4.1.2 Source/Platform
The platforms for the data collection were weather balloons.

4.1.3 Source/Platform Mission Objectives
The objective of the balloon was to carry the sonde up through the atmosphere.

4.1.4 Key Variables
The primary quantities measured, both on the surface and in the upper atmosphere, were pressure, temperature, humidity, wind direction and wind speed.

4.1.5 Principles of Operation
The radiosondes used a small battery-powered transmitter that relayed messages to a receiver on the ground. As the radiosonde passed through the atmosphere, the sensors detected changes in pressure, temperature, and humidity.

These changes were sent as signals to the receiver, which were then decoded as values of pressure, temperature, and humidity. An automatic tracking device determined the position of the radiosonde, which was translated into wind speed and direction by the receiver.

A radiosonde consisted of the following major components: Meteorological sensors that responded mechanically or electrically to changes in the parameters being measured (temperature, humidity, and pressure); a switching mechanism that connected the sensor outputs to the modulator circuitry; a modulator for regulating the carrier signal at a rate dependent on the electrical resistance of the temperature and humidity sensors; a transmitter for transmitting radio frequency signals back to the ground equipment; a power supply (battery) that produced the current required to operate the electronic circuitry; and a container or case made from polystyrene and cardboard used to house the electronic and mechanical components (this container was also designed to provide suitable exposure for the sensors).

4.1.6 Sensor/Instrument Measurement Geometry
The measurements made by the sensor or calculated from the measurements varied in their geometric representation depending on the flight conditions.

4.1.7 Manufacturer of Sensor/Instrument
Vaisala Radiosondes (Candle L., Churchill, Key L., Thompson):
Vaisala Inc.
100 Commerce Way
Woburn, MA 01801
Ph: (617) 933-4500
Fax: (617) 933-8029

VIZ (Saskatoon, Lynn Lake, The Pas (1996)):
VIZ Manufacturing Company
335 East Price Street
Philadelphia, PA 19144-5782
Ph: (215) 844-2626
Fax: (215) 844-4410

A.I.R. (Primrose L.):
Atmospheric Instrumentation Research, Inc.
8401 Baseline Road
Boulder, CO 80303
Ph: (303) 499-1701
Fax: (303) 499-1767

4.2 Calibration

4.2.1 Specifications

Vaisala: Radiosondes were factory calibrated. Calibration tape accompanying each radiosonde was fed into the MW15 prior to launch. A calibration correction was applied to RH as described in Section 9.1.

Vaisala (Candle Lake, Key Lake, Thompson and Churchill)
Radiosonde Description:
Type: Vaisala RS80 Series Description:
Pressure Sensor: Capacitive aneroid; Resolution: 0.01 kPa, Precision: 0.05 kPa
Humidity Sensor: Humicap thin film capacitor; Resolution: 1% RH;
Precision: 2% RH; Lag: 1 s (for 6 m.s-1 flow at 100 kPa)
Temperature Sensor: Capacitive bead; Resolution: 0.1 deg C;
Precision: 0.2 deg C;
Lag: < 2.5 s (for 6 m/sec flow at 100 kPa)
Wind Direction and Speed: NAVAID (Loran-C or Omega)
Radiosondes were factory calibrated. Calibration tape accompanying each radiosonde was fed into the MW15 prior to launch. A calibration correction was applied to RH as described in section 9.1.

VIZ W9000 (Saskatoon, Lynn Lake, The Pas - 1996)
Radiosonde Description:
Type: VIZ-BEUKERS LO-CATE MICROSONDE
Pressure Sensor: Aneroid capsule (Ni-Span-C); Resolution: 0.01 kPa;
Precision: 2 kPa
Humidity Sensor: carbon type, 10000; Resolution: .01% RH; Precision: 4% RH
Temperature Sensor: Thermistor, rod type, 1400 ohms; Resolution: 0.01 deg
C; Precision: 0.4 deg C
Wind Direction and Speed: NAVAID (Loran-C or Omega)
Radiosondes were factory calibrated.

A.I.R.
Radiosonde Description:
Type: A.I.R.
Intellesonde Description:
Pressure Sensor: aneroid pressure cell; Resolution: 0.01 kPa; Precision: 1 kPa
Humidity Sensor: carbon hygristor; Resolution: .01% RH; Precision: 3% RH
Temperature Sensor: Thermistor; Resolution: 0.01 deg C; Precision: 0.5 deg C
Wind Direction and Speed: Automatic Digital Radiotheodolite
Each Intellisonde was factory calibrated with calibration coefficients stored in read-only memory (ROM). These coefficients were automatically transmitted to the receiver on power-up.
Radiosondes were factory calibrated. Calibration coefficients were transmitted by the radiosonde.

ADRES, The Pas - 1994.
Radiosonde Description:
Temperature Sensor: Thermistor
Wind Direction and Speed: Radiotheodolite

4.2.1.1 Tolerance

Upper-air Observations:

Vaisala
A radiosonde was accepted if:

- Temperature reading was within +/- 2° C of the manually observed temperature;
- Pressure was within +/- 5 mb of the manually observed pressure;
- Relative humidity was within +/- 20 percentage points of the manually observed relative humidity.

Precision (Vaisala UAD Technical Manual):
The following data were based on the twin ascent method. Two Vaisala series RS 80 radiosondes were suspended from one balloon and tracked by two independent receiving systems. The standard deviation of the differences was obtained after a number of ascents. Pressure measurement precision (1060 to 3 mb) is 0.05 mb. Temperature measurement precision was 0.2° C and humidity was 3%. Wind vector measurement precision was 2 knots typical (Omega/Alpha) and 1 knot typical (Loran-C).

VIZ
A radiosonde was accepted if pressure was stable and was within 5 mb of the standard pressure measurement.

A.I.R.
The A.I.R. software compared the manually entered surface observation and alerted the user if a variable was far enough out of range to justify rejection of the radiosonde.

Surface Observations: Not applicable.

4.2.2 Frequency of Calibration

Upper-air:

- Each radiosonde was checked against the surface observation before release.

Surface Observations:

- Surface pressure sensors at Candle Lake, Saskatoon and Thompson were checked against the AES regional standard pressure sensor prior to installation. Checks were performed at the beginning and end of the 1994 BOREAS field season.
- The surface pressure sensor at The Pas was checked once a year against the AES traveling standard pressure sensor, which in turn, was checked against the AES regional standard.
- No checks were performed on the ordinary thermometers used at Candle Lake, Thompson Zoo, Saskatoon and Key Lake.
- The dew cell sensors at Key Lake and Churchill were checked once a week in 1994.

4.2.3 Other Calibration Information

None.

5. Data Acquisition Methods

Vaisala Data Reception and Signal Processing

Radiosonde (wind) tracking: NAVAID (Loran-C or Omega);
Receiver: DigicoraII MW15

The Vaisala receiver (MW15) received and processed radiosonde signals in real time. The signals were converted to pressure, temperature and relative humidity and wind, and transferred to a PC. After all signals were converted to pressure, temperature, relative humidity and wind speed and direction, proprietary higher level processing was conducted. Main Functions of the Main Processor Unit (p.12 Vaisala UAD Technical Manual):

- Error message handling and diagnostic analysis: Monitors operations by sending a message to the console upon detecting an error. Reads and analyzes error maps from other processor boards. If an error occurs, control is taken over by the error message handler.
- Console command handling: Interprets commands given via console to application programs and to other processor boards.
- Data handling and operational control: Transfers untreated, raw data from the receiver for processing, editing and smoothing programs. Detects radiosonde launch and radiosonde burst.

DATA EDITING (Appendix A, p.1 Vaisala UAD Program Manual)

Using established physical equations, the raw data (at two, five or ten second intervals) are edited to obtain the so-called filtered data. The purpose of data editing is to reject physically inconsistent data points. Editing is a nonlinear, non-recursive method of data quality control. It is necessary because of the presence of telemetry noise which tends to distort the determination of the signal frequency. Data editing is carried out in real time. There are four phases: - coarse filtering - fine filtering - completion of the data set by interpolation - data smoothing between turning points

WIND EDITING (Appendix B, p1 Vaisala UAD Program Manual)

The wind vector is computed based on the rate of change of the signal phase (phase derivatives) which is caused by the movement of the radiosonde. The rate of change of the phase depends on the movement of the radiosonde with respect to the transmitters and on the change in the distance between the radiosonde and the ground station. The basic solution is the so-called hyperbolic solution where at least three signals are needed to locate the radiosonde and to compensate for drift of the local oscillator and the change in the distance between the radiosonde and the ground station.

Computed wind vectors are passed through a quality control program to ensure that deviating vectors are rejected. Cubic spline fitting method is used to smooth the wind data after all stray points are rejected (according to Grubbs criterion).

VIZ W9000 (Saskatoon, Lynn Lake, The Pas - 1996)

A basic system consisted of the following:

- Preamplifier/Antenna- Local NAVAID Antenna
- A rack with a P90 bus interconnecting the backplane with the following:
- 403 MHz Synthesized Receiver Module
- System Interface Module
- 403 Mhz Antenna Control Module
- Loran-C or Omega Amplifier Modules
- NAVAID Tracker Module(s)
- System computer, keyboard, hard drive and two floppy drives
- Color monitor
- Printer

Winds were determined by either Loran or Omega tracking. All available Loran chains or Omega stations were displayed to the user. The chains or stations were selected for the current tracker.

A.I.R.

Pressure was measured from 1050 to 5 mb by a capacitance type pressure sensor. An internal temperature sensor located near the pressure sensor provided temperature compensation. Temperature was measured by a precision thermistor protected by a reflective coating intended to minimize radiation errors at high altitude. Relative humidity was measured by a carbon hygristor mounted on a double-shielded aerodynamic duct.

The automatic ground station included an IBM compatible computer with an A.I.R. data decoder board installed in a standard expansion slot. The computer was used to calculate pressure, temperature humidity and winds. The calculated parameters were then archived on the computer's hard disk.

The A.I.R. system at Primrose Lake received 250mW radiosonde transmissions which were decoded and transferred to a personal computer where unmodified pressure, temperature and humidity data were saved.

Wind data were automatically gathered using the A.I.R. Automatic Digital Radiotheodolite. This mechanism used a microprocessor controlled planar phased array rather than a parabolic dish for tracking. The A.I.R. radiotheodolite electronically measured the small tracking error associated with the slew rate of the antenna and corrected the output signal generated by the optical encoders. The antenna position, combined with the pressure, temperature and humidity data from the radiosonde was used by the ground station to compute wind speed and direction. The receiver, control microprocessor, power supply and switching array all were housed within the radiotheodolite.

The radiosonde type used was a 1680 MHz Intellisonde, which was manufactured by A.I.R. The Intellisonde measured temperature, humidity and pressure with digital precision. Sensor output was converted to digital words in the radiosonde. Pressure, temperature, humidity data and sensor references were then formatted into a digital message. Contamination of pressure, temperature and humidity data by telemetry noise was determined by error detection codes.

ADRES:

ADRES is a Canadian rawindsonde system designed and produced by AES. It was in use for twenty years and is being phased out. The Pas was one of the last existing ADRES stations in Canada. ADRES was designed to partially automate upper-air soundings while allowing significant observer intervention. Significant and mandatory level data were read manually from strip charts. The data were then entered manually and processed by the ADRES software. The observer was limited to a maximum of sixty levels.

A 1680 MHz radiosonde was the instrument launched. The pressure was measured by means of a temperature-compensated single cell aneroid. Temperature was measured using a thermistor. This thermistor was a thin rod of semiconductor ceramic material with a negative temperature coefficient of electrical resistance. Humidity was measured using an electrolytic element called a hygristor, whose electrical resistance varied proportionally to the relative humidity of the air. The hygristor consisted of a small plastic strip coated with a thin film of carbon. The two long edges were coated with metallic electrodes between which the resistance measurements were made.

Candle Lake Surface Observation Instruments and Method

Dry and wet bulb temperatures were manually read from mercury in glass thermometers mounted in a non-ventilated Stevenson screen. Depending on dew point temperature, the wet bulb thermometer was moistened using either a wick or a muslin sleeve. When the wet bulb temperature was greater than 0° C, a wick was used. A muslin sleeve was used when the wet bulb temperature ranged from 0° C to -10° C. The sleeve or wick was replaced once weekly.

Temperature and dew point measurements were then corrected according to the factor specified by the thermometer serial number. Non-ventilated psychrometric tables were used to determine dew point temperature and relative humidity after the correction had been applied.

An instantaneous pressure value was manually taken using a Druck pressure sensor. No correction was applied.

A two minute average of wind speed and direction was estimated by the observer. Wind direction was estimated in eight-point compass degrees.

In 1996, a sling psychrometer was used to measure surface temperature and humidity. Wind speed

and direction were taken as a 2-minute average measured electronically by an anemometer. Pressure was taken from an aneroid barometer.

Thompson Surface Observation Instruments and Method

Temperature and humidity were measured following the same procedure as at Candle Lake. The only difference was that the dry and wet bulb thermometers were in a ventilated Stevenson screen; therefore, ventilated psychrometric tables were used to determine dew point temperature and relative humidity.

Two minute averages of wind direction and speed were measured using the U2A wind measurement system. Direction was read to 10 degrees and speed to one knot.

An instantaneous pressure value was manually read using a Setra 270 pressure sensor. No correction was applied.

In 1996, a sling psychrometer was used to measure surface temperature and humidity. Wind speed and direction were taken as a 2-minute average measured electronically by an anemometer. Pressure was taken from a Setra pressure transducer.

Key Lake and Churchill Surface Observation Instruments and Method

Temperature and humidity readings were taken by a READAC automatic weather station. The temperature sensor type was a thermistor and the humidity sensor was a lithium chloride dew cell. Both were housed in a ventilated Stevenson screen 1.25m above the ground. No corrections were applied.

Pressure was measured via two Setra sensors; the lower of the two readings was output. Wind direction and speed were measured using 78D sensors. These sensors use vector averaging to calculate two minute wind direction and speed.

In the event of automatic weather station failure, standard thermometers also housed in the READAC were used. If the wind sensors were not available, an estimation of wind direction was determined using the eight points of the compass and wind speed was estimated in knots.

No data were measured at Key Lake during BOREAS 1996. Surface observations at Churchill were not investigated for BOREAS 1996.

The Pas Surface Observation Instruments and Method

Temperature and humidity were measured in a ventilated Stevenson screen using a dew cell and thermistor. Temperature and dew point were displayed instantaneously. No correction was applied.

Wind was measured using the same method as outlined for Thompson Zoo.

Pressure was measured using a standard mercury barometer. No correction was applied.

BOREAS 1996: In 1996, surface observations were not taken at The Pas.

Saskatoon Surface Observation Instruments and Method

Temperature and wet bulb temperatures were measured using a sling psychrometer. Relative humidity and dew point were determined via psychrometric tables. No corrections were applied.

Pressure was measured by a Ruska digital barometer that was situated approximately 11m higher than the radiosonde release point. A correction for this height discrepancy was applied during processing.

Wind direction and speed were determined from the U2A output generated by the automatic weather station.

Primrose Lake Surface Observation Instruments and Method

Temperature and dew point - same as at Candle Lake and Thompson Zoo (BOREAS 1994).

Pressure sensor - displayed instantaneous pressure. Wind direction and speed displayed instantaneously by dials or was determined from wind direction and speed plotted on a rolling strip chart.

Two ordinary thermometers (same as at Candle Lake and Thompson Zoo for BOREAS 1994) were housed in a ventilated Stevenson screen. Dew point temperature was determined using the same method as at Candle Lake and Thompson Zoo except that ventilated psychrometric tables were used to

determine the relative humidity and dew point. It is unknown what procedure was followed regarding the wick/muslin sleeve or if corrections were applied for each thermometer.

A two minute wind average was measured using a U2A instrument (as described for Thompson Zoo for BOREAS 1994). Winds may also have been observed from a strip chart produced by the U2A system.

Pressure was measured using a standard mercury barometer. No correction was applied.

6. Observations

6.1 Data Notes

The following table contains field notes and is organized by date. Note: The sone release times are listed in GMT (also called Zulu, abreviated by the letter Z). Thus, 11Z is 11 Zulu, or 11:00 GMT.

Site Name	Date and Time	Comments
Key Lake	94-Apr-12 17Z	Early burst, second release performed.
Candle Lake	94-Apr-13 11Z	RH incorrectly calculated using a correction for wet bulb of -1.0 instead of -0.1. RH was entered as 41% instead of 54%. Dew point may be recorded incorrectly.
	94-Apr-13 17Z	Dew point may be incorrect.
Saskatoon	94-Apr-13 17Z	No wind data.
	94-Apr-13 23Z	No wind data.
Candle Lake	94-Apr-14 11Z	Light snow at release time, turning into heavy snow, quit at 1230. Local power surge followed by outage at 11:32, 11:33, 11:45 and 12:02. Outage at 12:02 - remained out until flight terminated.
Saskatoon	94-Apr-14 23Z	Computer lost sonde signal.
	94-Apr-15 23Z	No flight information - radiosonde technical problems.
Candle Lake	94-Apr-16 17Z	String connecting radiosonde to balloon did not appear to unwind fully.
Saskatoon	94-Apr-16 11Z	No flight information - radiosonde technical problems.
	94-Apr-16 17Z	No flight information - radiosonde technical problems.
Thompson	94-Apr-18 11Z	Lost signal - unable to find.
	94-Apr-19 11Z	Old looking balloon
	94-Apr-19 17Z	Old looking balloon
	94-Apr-20 17Z	Lost signal for a while.
Candle Lake	94-Apr-21 11Z	String did not appear to unwind.
Key Lake	94-Apr-21 11Z	This flight was very short. The balloon had burst at 49min 20sec.
	94-Apr-22 11Z	This flight was unsuccessful due to an early burst. Second release will be performed.

Thompson	94-Apr-22 11Z	Second launch.
Candle Lake	94-Apr-23 11Z	String did not appear to unwind.
Key Lake	94-Apr-23 11Z	Poor weather and poor visibility delayed arrival to site (about 5AM).
Candle Lake	94-Apr-24 11Z	Problem with wet bulb temperature therefore RH was entered at 72%, which was the local Environment Canada calculation at 10:00Z.
Key Lake	94-Apr-24 11Z	Balloon burst early at 38min 30sec.
Thompson	94-Apr-24 11Z	Had problems with signal between 90 mb and 60 mb.
	94-Apr-24 17Z	Lost signal between 232 mb and 192 mb
Saskatoon	94-Apr-25 17Z	Manual flight end.
Thompson	94-Apr-25 11Z	Lost signal for a while.
	94-Apr-25 17Z	Lost signal for a while.
	94-Apr-25 11Z	Lost signal for a while.
Candle Lake	94-Apr-26 11Z	Problem with RH -- METHOD?
Key Lake	94-Apr-26 17Z	Flight was unsuccessful due to an early burst, a second release will be performed.
Thompson	94-Apr-26 11Z	Lost wind direction and speed for a while.
	94-Apr-26 17Z	Lost signal around 90 mb.
Key Lake	94-Apr-27 17Z	Flight was unsuccessful due to an early burst, a second release will be performed.
Thompson	94-Apr-27 11Z	First radiosonde rejected. Surface temperature should be -10.0 instead of 10.0.
Candle Lake	94-Apr-28 11Z	String did not appear to unwind.
Saskatoon	94-Apr-28 17Z	No wind data.
Candle Lake	94-Apr-29 11Z	String did not appear to unwind.
Key Lake	94-Apr-30 11Z	Flight was delayed due to a defective balloon.
Thompson	94-Apr-30 17Z	Clock set on Digicora and computer.
	94-May-02 11Z	Radiosonde temperature gauge broken. Unable to make a copy of the April 30 diskette. Having trouble with telemetry, Digicora said that data were out of bounds. Monitoring sonde returned. Lost wind direction and speed at 94.2 mb.
Candle Lake	94-May-24 11Z	Balloon had a visible weak spot on one side but it did not seem to have any effect.
	94-May-24 23Z	Radiosonde failure.

Key Lake	94-May-24 11Z	Flight was unsuccessful. Second release will be performed. There was missing data for wind direction/speed (5min 25sec to 11min 35sec and 12min 15sec to 17min 45sec and 20min 55sec to termination). Range missing from 5min 25sec to termination.
	94-May-24 17Z	There was an electrical outage from 9:30AM(CST) to 11:45AM (CST). Because there was no power, the automatic weather station was inoperative. The surface weather observation was taken manually from the Stevenson screen barometer, wind charts and psychrometric tables.
Candle Lake	94-May-25 11Z	String did not unwind.
	94-May-25 20Z	Re-launch just after 20:00Z because two bad humidities on sondes forced two re-launches. Authorized by Alan Betts.
	94-May-25 21Z	MW15 possibly picked up another instrument still in the air even though radio frequencies of the second release was 401.38. Flight automatically ended at 21:50Z. No second release attempt due to time constraints.
Key Lake	94-May-25 11Z	Flight was delayed due radiosonde difficulties. The first one was rejected due to a high humidity reading (153%). The second and third radiosondes give similar readings but did not correspond within range for the READAC's observations. The second and third radiosondes were giving acceptable readings. Since there was very little time, the Stevenson screen was used for the temperature, dew point, and RH. The radiosonde was unacceptable range in relation to the Stevenson screen. The psychrometric table was unclear to what the RH factor was. 49% was used for the observation.
Thompson	94-May-25 11Z to 94-Jun-06 15Z	No wind information.
Candle Lake	94-May-26 19Z	Manual termination due to bad data. 100% RH and bad temperature.
The Pas	94-May-26 17Z	Strong convection, lots of ascent rate changes and superadiabatic layers.
	94-May-26 23Z	Many supers off surface (7). MISDA STRATUM DUESCT. SGN. NO APPARENT CAUSE.??
Key Lake	94-May-27 23Z	Flight was unsuccessful due to an early burst. Second release will be performed.
The Pas	94-May-27 11Z	Many supers!!
	94-May-27 17Z	Many supers!!!
Saskatoon	94-May-28 19Z	Second launch.
The Pas	94-May-28 17Z	Many supers. Ground equipment trouble delayed release.

Candle Lake	94-May-29 11Z	No wind data until 484hPa. Winds lost again at 250hPa.
	94-May-29 19Z	Flight released at 19:03Z at Alan Betts' request. Rain showers approaching.
	94-May-29 21Z	Flight released at 21:08 at Alan Betts' request.
	94-May-30 11Z	No wind data until 544.9hPa.
	94-Jun-01 11Z	Balloon has a very irregular shape. No wind data until 862hPa.
	94-Jun-01 15Z	No wind data until 794hPa.
Key Lake	94-Jun-03 11Z	Flight was unsuccessful. Second release will be performed. There was missing data for wind direction/speed (6min 5sec to 15min 55sec and 17min 25sec to termination. Range missing from 6min 5sec to termination.)
The Pas	94-Jun-03 17Z	Power failure near end. ADRES used to finish.
Candle Lake	94-Jun-04 11Z	Odd shaped balloon. Balloon was touching top of tent - may be over 500 grams.
Key Lake	94-Jun-04 11Z	Flight came very close to being delayed because the READAC's observations were not corresponding within range with the radiosondes. Three radiosondes were compared with the READAC's observations. All three gave similar readings but were slightly out of range with the READAC. The radiosonde was in range with the Stevenson screen. The READAC was also not giving wind observations. The winds were estimated for direction and speed.
	94-Jun-04 17Z	Flight was unsuccessful. Second release will be performed. There was missing data for wind data from 30min 25sec to termination.
	94-Jun-05 11Z	Flight was unsuccessful because the receiver had lost the signal from the sonde. Second release will be performed.
	94-Jun-05 17Z	Flight was unsuccessful because the receiver had lost the sonde's signal. Second release will be performed.
The Pas	94-Jun-05 11Z	Many supers off surface.
	94-Jun-05 23Z	Instrument hit CB base.
Candle Lake	94-Jun-06 11Z	String did not unwind.
Key Lake	94-Jun-07 11Z	Flight was unsuccessful. There was missing wind data from 22min 35sec to termination. Second release will be performed.
Candle Lake	94-Jun-08 11Z	Approximately 20 minutes into the flight TELEM became very weak - RH jumping from 8% to 160%. Flight ended -second release.
	94-Jun-08 12Z	String did not fully unwind. TELEM problems.
	94-Jun-08 19Z	String did not appear to unwind all the way.
Key Lake	94-Jun-08 12Z	Surface wind direction and speed were estimated. This was required because the READAC was giving no wind observations.

Candle Lake	94-Jun-09 11Z	String did not unwind fully.
	94-Jun-10 11Z	Balloon slightly lopsided. Didn't look like string unwound all the way.
	94-Jun-10 19Z	Signal very weak.
Key Lake	94-Jun-10 11Z	The sonde was not in range with the READAC. Three sondes were tried and compared to the READAC but were all out of range. All three sondes were giving similar readings. Stevenson screen was compared to the sondes and was found to be within range.
Saskatoon	94-Jun-10 19Z	Third launch. First launch - lost signal and ended flight. Second launch - couldn't locate sonde.
Candle Lake	94-Jun-11 11Z	String only unwound as far as the plastic antennae cord then stopped.
Key Lake	94-Jun-11 12Z	Flight was unsuccessful. Flight ended at about 13:20 Greenwich Mean Time (GMT). Because there was little time left, a third release was not performed. There was missing wind data from 11min 55sec to termination.
	94-Jun-11 23Z	Flight was unsuccessful due to an early burst. Second release will be performed.
	94-Jun-12 11Z	Unsuccessful flight. Second release will be performed. There was missing wind data from 25min 45sec to termination.
	94-Jun-12 23Z	A power outage made the READAC inoperative. Observations were taken manually.
Candle Lake	94-Jun-13 11Z	String did not fully unwind.
	94-Jun-13 23Z	String unwound only to end of plastic cord (again).
Saskatoon	94-Jun-13 00Z	Second launch. First launch - sonde not located at launch.
Primrose Lake	94-Jun-14 17Z	Balloon defect.
Saskatoon	94-Jun-14 23Z	Second launch. First launch - sonde not located at launch.
Candle Lake	94-Jun-15 13Z	String did not unwind at launch.
	94-Jun-15 15Z	String did not unwind at launch.
	94-Jun-15 17Z	String did not unwind at launch.
	94-Jun-15 19Z	String did not unwind at launch.
Key Lake	94-Jun-15 23Z	Surface observations taken manually. The READAC was not on line.
Primrose Lake	94-Jun-15 12Z	Balloon burst.
Saskatoon	94-Jun-15 18Z	Second launch. First launch - sonde not located at launch.
	94-Jun-15 23Z	Second launch. First launch - sonde not located at launch.

Thompson	94-Jun-15 11Z	Snow, rain and fog outside.
Candle Lake	94-Jun-16 11Z	String only unwound to end of plastic cord.
	94-Jun-16 13Z	String only partially unwound.
Key Lake	94-Jun-16 11Z	Flight delayed - alarm clock failed to go off.
Saskatoon	94-Jun-16 23Z	Second launch. First launch - sonde not located at launch.
The Pas	94-Jul-18 23Z	5 supers.
Candle Lake	94-Jul-19 11Z	Early burst.
	94-Jul-19 12Z	Second release. Early burst??
	94-Jul-19 12Z	Third release. Early burst??
	94-Jul-19 23Z	Technical problems delayed release.
Saskatoon	94-Jul-19 18Z	Second release. First release - lost sonde signal at launch.
Thompson	94-Jul-19 11Z	Second release. Technical problems on first release.
The Pas	94-Jul-19 11Z	Late release.
Key Lake	94-Jul-21 23Z	LORAN reception was very poor. This caused a large amount of wind data loss.
Lynn Lake	94-Jul-21 11Z	National Scientific Balloon Facility (NSBF) balloon: used a special, large mylar balloon to obtain high altitude wind data above 5mb.
Saskatoon	94-Jul-21 18Z	Second release. First release - lost sonde signal at launch.
Churchill	94-Jul-22 11Z	No winds.
Saskatoon	94-Jul-22 00Z	Second release. First release - lost sonde signal at launch.
Churchill	94-Jul-23 11Z	Second release. No flight - equip. fail.
Key Lake	94-Jul-23 11Z	LORAN reception was very poor. This caused a large amount of wind data loss.
The Pas	94-Jul-23 23Z	5 supers.
Churchill	94-Jul-24 11Z	Second release.
Key Lake	94-Jul-24 23Z	Flight was unsuccessful. Second release will be performed. There was missing wind data from 7min 45sec to 22min 45sec and 33min 55sec to termination.
The Pas	94-Jul-24 23Z	5 supers.
Candle Lake	94-Jul-25 11Z	Surface data entered in error as 66% (correct RH not available).
Churchill	94-Jul-25 11Z	No winds.
Lynn Lake	94-Jul-25 11Z	NSBF High Altitude Balloon.

Saskatoon	94-Jul-25 11Z	Second launch - lost sonde signal at launch.
The Pas	94-Jul-25 17Z	Early release - observer error.
Saskatoon	94-Jul-26 13Z	Third release. First and Second release - lost sonde signal at launch.
Candle Lake	94-Jul-27 19Z	2 low ascent rates - balloons inflated the same as usual.
Churchill	94-Jul-27 12Z	Second release. No winds for first release.
Key Lake	94-Jul-27 17Z	No wind data.
Saskatoon	94-Jul-27 00Z	Second release. First release - lost sonde signal at launch.
	94-Jul-27 12Z	Second release. First release - lost sonde signal at launch.
The Pas	94-Jul-27 17Z	4 supers.
	94-Jul-27 23Z	6 supers.
Lynn Lake	94-Jul-28 11Z	Special NSBF balloon.
	94-Jul-29 11Z	Special NSBF balloon.
Saskatoon	94-Jul-29 12Z	Second release. First release - lost sonde signal at launch.
	94-Jul-30 11Z	No winds. Second release required.
	94-Jul-30 12Z	Third release. Second release - lost sonde signal at launch.
	94-Jul-30 18Z	Second release First release - lost sonde signal at launch.
	94-Jul-31 18Z	Three attempts to release - lost sonde signal at launch for all three. No flight information.
	94-Aug-01 00Z	Second release. First release - lost sonde signal at launch.
	94-Aug-01 14Z	Third release. First and second release - lost sonde signal at launch.
The Pas	94-Aug-01 11Z	3 supers.
Primrose Lake	94-Aug-02 12Z	No flight due to conflict with range operations.
Saskatoon	94-Aug-02 12Z	Second release. First release - lost sonde signal at launch.
Thompson	94-Aug-02 13Z	Launch delayed. Operator had to wait for approval from flight control until 13:42Z, then when balloon released, the twine between the balloon and the sonde broke. The sonde was damaged in the fall. Second release made.
	94-Aug-02 19Z	Launch delayed by air traffic control.
The Pas	94-Aug-02 11Z	3 supers.

Key Lake	94-Aug-03 17Z	Flight was unsuccessful. There was missing wind data from 0min 5sec to 5min 5sec and 5min 25sec to 10min 15sec and 16min 45sec to 28min 15sec and 28min 55sec to 34min25sec and 34min 35sec to termination. Second release will be performed.
Lynn Lake	94-Aug-03 11Z	Special NSBF balloon. No data recorded for first run.
Primrose Lake	94-Aug-03 12Z	No flight due to conflict with range operations.
Saskatoon	94-Aug-03 11Z	Second release. First release - lost sonde signal at launch.
Saskatoon	94-Aug-03 18Z	Second release. First release - lost sonde signal at launch.
Key Lake	94-Aug-04 23Z	Flight was unsuccessful, There was missing wind data from 7min 15sec to termination. Second release will be performed.
Primrose Lake	94-Aug-04 and 94-Aug-05	No flights due to base commitments.
Saskatoon	94-Aug-04 12Z	Second release. First release - lost sonde signal at launch.
The Pas	94-Aug-04 17Z	2 supers.
	94-Aug-04 23Z	4 supers.
Lynn Lake	94-Aug-05 11Z	Special NSBF balloon.
Thompson	94-Aug-05 15Z	Launch delayed by air traffic control.
The Pas	94-Aug-05 17Z	2 supers.
	94-Aug-05 23Z	4 supers.
Saskatoon	94-Aug-06 13Z	Second release. First release - lost sonde signal at launch.
	94-Aug-06 23Z	Flight lost - terminated and disk save.
Thompson	94-Aug-06 11Z	Not able to make this flight as keys to the zoo had been lost during the evening. Not able to access the zoo until 9AM.
Lynn Lake	94-Aug-07 11Z	Special NSBF balloon.
The Pas	94-Aug-07 17Z	6 supers.
Primrose Lake	94-Aug-08 17Z	Flight ended at 200mb (low stability sonde used).
Saskatoon	94-Aug-08 23Z	Omega tracking. Winds mostly missing.
The Pas	94-Aug-08 17Z	6 supers.
Saskatoon	94-Aug-09 01Z	Omega tracking. Second launch.

The Pas	94-Aug-30 17Z	6 supers.
	94-Aug-30 23Z	6 supers.
Saskatoon	94-Aug-31 17Z	No wind data.
The Pas	94-Aug-31 11Z	1 super.
	94-Aug-31 17Z	5 supers.
	94-Aug-31 23Z	7 supers.
Saskatoon	94-Sep-01 11Z	No wind data.
The Pas	94-Sep-01 17Z	1 super.
	94-Sep-01 23Z	4 supers.
Saskatoon	94-Sep-02 11Z	No wind data.
	94-Sep-02 17Z	No wind data.
The Pas	94-Sep-02 17Z	1 super.
	94-Sep-02 23Z	4 supers.
Saskatoon	94-Sep-03 12Z	Second launch. First launch - stuck in monitoring for launch mode.
Thompson	94-Sep-03 12Z	Sonde late because Charles Fenner (operator) did not show up. Launched by Alan Betts and Jo Lutley.
The Pas	94-Sep-03 17Z	Power failure - ADRES crash. ADRES used to finish. No winds.
	94-Sep-04 23Z	1st release at 23:15 failed due to G.E.F.
Key Lake	94-Sep-07 11Z	Flight was unsuccessful due to a signal loss. Second release will be performed. Surface observations were taken manually because the READAC was not giving any data due to a hard disk drive failure.
	94-Sep-07 13Z	Flight was delayed because the computer had difficulties sending out the UM, UG, UF and UQ data. Observations were taken manually because the READAC still had a hard disk drive failure. As of 13:50 GMT, security reports the READAC in good working order and READAC observations will be available for the 18:00 Zulu flight.
Thompson	94-Sep-07 23Z	Surface RH needs correction in data: to 54% -wick was loose.
Saskatoon	94-Sep-08 00Z	Second launch. First launch - sonde located; monitor for launch mode.
The Pas	94-Sep-08 13Z	Late release - operator slept in.
Candle Lake	94-Sep-10 15Z	Late because first sonde had bad humidity. Weak telemetry.

Key Lake	94-Sep-10 11Z	Flight was delayed because the first radiosonde would not give any surface weather conditions. Receiver indicated no signal even though the radiosonde was transmitting a strong signal. This radiosonde was rejected. The second radiosonde was good.
Saskatoon	94-Sep-10 01Z	Second launch. First launch - sonde located; monitor for launch mode.
	94-Sep-10 13Z	Second launch.
The Pas	94-Sep-10 11Z	4 supers.
	94-Sep-10 17Z	4 supers.
	94-Sep-10 23Z	3 supers. Missing RH 960mb to 896mb.
Key Lake	94-Sep-11 11Z	Surface observations were taken manually because the READAC was not on line with the security gate house.
	94-Sep-11 17Z	Surface observations were taken manually because the READAC still remains inoperative.
The Pas	94-Sep-11 23Z	2 supers.
	94-Sep-12 17Z	1 super. Transponder sonde.
	94-Sep-12 23Z	2 supers.
	94-Sep-13 11Z	2 supers.
Key Lake	94-Sep-14 11Z	No flight was performed because there were no radiosondes. Radiosondes were shipped out during the middle of last week but still have not arrived at Key Lake.
The Pas	94-Sep-14 23Z	5 supers.
	94-Sep-14 11Z	3 supers.
Saskatoon	94-Sep-15 23Z	Loran tracking starts.
The Pas	94-Sep-15 23Z	3 supers.
Candle Lake	94-Sep-16 11Z	No wind at surface - darkness - couldn't see balloon.
Thompson	94-Sep-16 11Z	No flight (no explanation provided).
Churchill	94-Sep-17 12Z	Second release.
The Pas	94-Sep-17 11Z	4 supers.
	94-Sep-18 17Z	2 supers.
	94-Sep-18 23Z	6 supers.
Saskatoon	94-Sep-19 19Z	Second launch. First launch - flight went into disk save immediately.

Candle Lake	96-Jul-08 17Z	Sfc P entered incorrectly at release time. Changed from 967.3 to 966.3 (correction of -0.69 not applied to 966.3 because it was already applied in the field). Correction of -0.69 applied to the surface pressure as indicated on the barometer for the soundings listed below. Those not on the list below were corrected by the flight at the time of release. 96-Jul-09 15Z, 96-Jul-09 17Z, 96-Jul-09 21Z, 96-Jul-09 23Z, 96-Jul-10 11Z, 96-Jul-10 15Z, 96-Jul-10 17Z, 96-Jul-10 19Z, 96-Jul-10 21Z, 96-Jul-10 23Z, 96-Jul-11 11Z, 96-Jul-11 17Z, 96-Jul-11 23Z, 96-Jul-13 11Z, 96-Jul-13 15Z, 96-Jul-13 17Z, 96-Jul-13 19Z, 96-Jul-13 21Z, 96-Jul-13 23Z, 96-Jul-14 11Z, 96-Jul-14 15Z, 96-Jul-14 17Z, 96-Jul-14 19Z, 96-Jul-14 20Z, 96-Jul-14 21Z, 96-Jul-14 23Z, 96-Jul-15 11Z, 96-Jul-15 15Z, 96-Jul-15 17Z, 96-Jul-15 19Z, 96-Jul-15 21Z, 96-Jul-15 23Z, 96-Jul-16 11Z, 96-Jul-16 17Z, 96-Jul-16 23Z, 96-Jul-17 11Z, 96-Jul-17 17Z, 96-Jul-17 19Z, 96-Jul-17 21Z, 96-Jul-17 23Z, 96-Jul-18 11Z, 96-Jul-18 17Z, 96-Jul-18 23Z, 96-Jul-19 11Z, 96-Jul-19 17Z, 96-Jul-19 19Z, 96-Jul-19 21Z, 96-Jul-19 23Z, 96-Jul-20 11Z, 96-Jul-20 15Z, 96-Jul-20 17Z, 96-Jul-20 19Z, 96-Jul-20 21Z, 96-Jul-20 23Z, 96-Jul-21 11Z, 96-Jul-21 17Z, 96-Jul-21 23Z, 96-Jul-22 11Z, 96-Jul-22 15Z, 96-Jul-22 17Z, 96-Jul-22 19Z, 96-Jul-22 21Z, 96-Jul-22 23Z, 96-Jul-23 11Z, 96-Jul-23 17Z, 96-Jul-23 23Z, 96-Jul-24 11Z, 96-Jul-24 15Z, 96-Jul-24 17Z, 96-Jul-24 19Z, 96-Jul-24 21Z, 96-Jul-24 23Z, 96-Jul-25 11Z, 96-Jul-25 15Z, 96-Jul-25 17Z, 96-Jul-25 18Z, 96-Jul-25 23Z, 96-Jul-29 11Z, 96-Jul-29 15Z, 96-Jul-29 17Z, 96-Jul-29 19Z, 96-Jul-29 21Z, 96-Jul-29 23Z, 96-Jul-30 11Z, 96-Jul-30 15Z, 96-Jul-30 17Z, 96-Jul-30 19Z, 96-Jul-30 21Z, 96-Jul-30 23Z, 96-Jul-31 11Z, 96-Jul-31 15Z, 96-Jul-31 17Z, 96-Jul-31 23Z, 96-Aug-01 11Z, 96-Aug-01 15Z, 96-Aug-01 17Z, 96-Aug-01 19Z, 96-Aug-01 21Z, 96-Aug-01 23Z, 96-Aug-02 11Z, 96-Aug-02 15Z, 96-Aug-02 17Z, 96-Aug-02 19Z, 96-Aug-02 21Z, 96-Aug-02 23Z, 96-Aug-03 11Z, 96-Aug-03 17Z, 96-Aug-03 23Z, 96-Aug-04 11Z, 96-Aug-04 17Z, 96-Aug-04 23Z, 96-Aug-05 11Z, 96-Aug-05 17Z, 96-Aug-05 23Z
Candle Lake	96-Jul-09 11Z	No data available - software and technical problems during sounding.
Thompson	96-Jul-09 23Z	First and only flight done that day because helium for balloons had not been delivered until late in the day.
The Pas	96-Jul-09 11Z	Removed excess error messages in Flight Log (JNL) file.
	96-Jul-09 23Z	RH too high; Thermo data missing between 3 and 7 min.
Thompson	96-Jul-10 19Z	Vaisala RH bad - removed flight from archive
Saskatoon	96-Jul-10 23Z	Sonde signal lost prior to launch - picked up again at 926.63 mb. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Jul-11 23Z	Possibly poor signal above 500mb - reflected in thermo data. P increases and decreases alternately from approximately 14.4 to 16.03 min. Full resolution file archived but an interpolated version was not produced.
The Pas	96-Jul-11 11Z	Removed excess error messages in Flight Log (JNL) file.

Saskatoon	96-Jul-12 11Z	Possibly poor signal - reflected in thermo data. Out-of-range windspeed at 4min.
Thompson	96-Jul-12 23Z	Temperature and humidity probably interpolated by the Vaisala system from surface to approx. 950mb.
	96-Jul-13 15Z	Sfc RH entered incorrectly at launch time. Replaced the original value of 25% with 48% (which was the value shown in the surface observation log just prior to release).
Candle Lake	96-Jul-14 20Z	Flight ended at 2 min 12 sec. Although this flight was released during the hour of 21Z, it was named 20Z so as not to be confused with the second release, which was also launched during the hour of 21Z.
	96-Jul-17 17Z	Vaisala humidity probably too high.
Thompson	96-Jul-18 19Z	Surface RH probably too high - correction NOT applied.
Saskatoon	96-Jul-20 11Z	Bad Pressure data - removed flight from archive.
	96-Jul-20 23Z	No wind info.
Thompson	96-Jul-20 11Z	Temperature probably interpolated by the Vaisala system from surface to approx. 900 mb.
	96-Jul-21 23Z	Temperature and humidity possibly interpolated by the Vaisala system from surface to approx. 880mb.
The Pas	96-Jul-21 23Z	Launch and End of Flight time edited manually in Flight Log (JNL) file.
Thompson	96-Jul-25 17Z	Sfc P incorrect - should have been 998.9 rather than 989.9. Corrected this problem by adding 9 to all Pressure measurements in the sounding.
Candle Lake	96-Jul-26 22Z	Flight ended at 18 min. Although this flight was released during the hour of 23Z, it was named 22Z so as not to be confused with the second release, which was also launched during the hour of 23Z.
Saskatoon	96-Jul-26 11Z	Excess error messages in Flight Log (JNL) file removed manually.
The Pas	96-Jul-26 23Z	End of Flight time edited manually in Flight Log (JNL) file.
Thompson	96-Jul-27 22Z	Flight ended at 6 min 56 sec. Although this flight was released during the hour of 23Z, it was named 22Z so as not to be confused with the second release, which was also launched during the hour of 23Z
Saskatoon	96-Jul-28 11Z	Launch and End of Flight time edited manually in Flight Log (JNL) file.
Thompson	96-Jul-28 23Z	Sfc wet bulb temperature (of 16.4) accidentally entered into the u/a system instead of the actual surface temp of 24.6. This has been corrected.
Candle Lake	96-Jul-29 11Z	Sfc P entered incorrectly at release time. Changed manually from 964.1 to 963.1 (then -0.69 applied to 963.1).

Thompson	96-Jul-29 17Z	Sfc P incorrect - should have been 998.9 rather than 989.9. Corrected this problem by adding 9 to all Pressure measurements in the sounding. Temperature and humidity possibly interpolated by the Vaisala system from surface to approximately 930mb. Sfc RH also incorrect. Wet bulb temperature entered into the system instead of RH by mistake. Observed RH=79%. Unfortunately, the Vaisala system interpolated RH from the surfce to approximately 930mb using the incorrect RH (of 19%) as the starting point. Removed levels starting with the first above-surface level to 940.2 mb.
Saskatoon	96-Jul-30 23Z	P increases for a few levels near 50.4 minutes. P increases and decreases alternately from approximately 76.05 to 76.67 min. Full resolution file archived but an interpolated version was not produced.
The Pas	96-Jul-31 11Z	Launch time edited manually in Flight Log (JNL) file.
Saskatoon	96-Aug-01 11Z	Launch time edited manually in Flight Log (JNL) file.
	96-Aug-02 11Z	Launch time edited manually in Flight Log (JNL) file.
The Pas	96-Aug-03 23Z	First pressure following surface was higher than the surface pressure. Removed this level.
Saskatoon	96-Aug-05 11Z	Excess error messages in Flight Log (JNL) file removed manually.
	96-Aug-05 23Z	Launch time edited manually in Flight Log (JNL) file.
The Pas	96-Aug-05 11Z	Sonde signal lost prior to launch - picked up again at 921.21 mb. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
Saskatoon	96-Aug-06 23Z	Out-of-range wind speeds near end of flight.
Thompson	96-Aug-07 19Z	Manually measured sfc T/RH very different from Vaisala T/RH - possibly because ob. taken 28min prior to launch. Replaced sfc T/RH with HMP (autostation) values.
Saskatoon	96-Aug-09 11Z	No Temperature data.
Churchill	96-Oct-01 11Z	Errors in original site diskette. Repaired file but was unable to convert ASCII.

Saskatoon	96-Oct-04 23Z	Sonde signal lost prior to launch - picked up again at 896.7 mb. Time (sec) in raw file: 1326.5 P=945.78 (before lost signal) ---> then skipped to: 1599.7 P=896.7 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-05 11Z	End of Flight message patched into Flight Log (JNL) file.
	96-Oct-08 11Z	Sonde signal lost prior to launch - picked up again at 896.7 mb. Time (sec) in raw file: 142.6 P=955.19 (before lost signal) ---> then skipped to: 274.4 P=907.63 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-08 23Z	End of Flight message patched into Flight Log (JNL) file.
	96-Oct-09 11Z	Sonde signal lost prior to launch - picked up again at 731.6 mb. Time (sec) in raw file: 67.6 =962.41 (before lost signal) ---> then skipped to: 493.3 P=731.6 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-11 11Z	Removed P=971.48 at 1560.5 sec. in raw file. P goes bad after approx. 6 min. Removed from archive.
	96-Oct-12 11Z	End of Flight message patched into Flight Log (JNL) file. Sonde signal lost prior to launch - picked up again at 939.8 mb. Time (sec) in raw file:2316.2 P=952.72 (before lost signal) ---> then skipped to:2350.9 P=939.8 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-14 11Z	Possibly a poor signal between 750 and 475 mb.
	96-Oct-14 23Z	Flight not available.
	96-Oct-15 11Z	Flight not available.
The Pas	96-Oct-15 23Z	End of Flight message patched into Flight Log (JNL) file.

Saskatoon	96-Oct-16 23Z	Sonde signal lost prior to launch - picked up again at 667.86 mb. Time (sec) in raw file: 0.0 P=955.2 (before lost signal) ---> then skipped to: 12.9 P=667.86 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-17 11Z	Sonde signal lost prior to launch - picked up again at 949.54 mb. Time (sec) in raw file: 124.1 P=960.97 (before lost signal) ---> then skipped to: 156.3 P=949.54 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-17 23Z	Full resolution data not archived. Significant and mandatory levels available.
	96-Oct-18 11Z	Sfc P incorrect. Sfc P at YXE (airport) = 1012.7. Probably P was entered as 905.7, instead of 950.7. Used P=949.9, which was taken approx. 30 min prior to release.
The Pas	96-Oct-18 23Z	Flight data file n/a - used a hardcopy version of significant and mandatory level data.
Saskatoon	96-Oct-19 00Z	Sonde signal lost prior to launch - picked up again at 920.52 mb. Time (sec) in raw file:2058.1 P=938.19 (before lost signal) ---> then skipped to:2094.0 P=920.52 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-19 23Z	Edited a bogus "Launch Detected" time into Flight Log (JNL) file. Also, an extra "Operator Edited Launch" message removed from Flight Log (JNL).
The Pas	96-Oct-19 11Z	Full resolution thermo data file not available. Used significant and mandatory level data.

Saskatoon	96-Oct-20 11Z	Sonde signal lost prior to launch - picked up again at 948.3 mb. Time (sec) in raw file:1463.3 P=956.54 (before lost signal) ---> then skipped to:1509.0 P=948.3 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate
	96-Oct-21 11Z	Sonde signal lost prior to launch - picked up again at 916.94mb. Time (sec) in raw file:1486.2 P=961.75 (before lost signal) ---> then skipped to:1595.9 P=916.94 (when signal found again). Assumed that launch occurred somewhere in between. Applied a correction to elapsed time by determining the ascent rate using the 1st and 20th observation (following the surface ob.) AscentRate=(Height2-Height1)/(Time2-Time1) TimeToAdd=(Height1-SiteElev.)/AscentRate

6.2 Field Notes

See Section 6.1

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

The upper-air data were recorded from several stations that span the BOREAS study region. The North American Datum of 1983 (NAD83) corner coordinates of the 1,000- x 1,000-km BOREAS study 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

The description of the individual launch sites follow:

Candle Lake (BOREAS 1994 and 1996)

The Vaisala Digicora II MW15 was located inside the Sno-Drifters Lodge on the Recreation Center grounds. The building used to inflate the balloons (1994 only) was located on the west side of the Sno-Drifters Lodge. The Sno-Drifters Lodge was in the northeast corner of a somewhat rectangular clearing measuring approximately 260 meters wide and 170 meters across. The clearing was surrounded by 12- to 15-meter-tall trees of a mixed variety.

The Stevenson screen (BOREAS 1994) was located along the northern edge of the clearing about 9 meters away from the Sno-Drifters Lodge. The exposure was nonstandard because more appropriate spots near the Lodge were used as fuel caches and as a helicopter landing pad.

The surrounding topography was somewhat hilly boreal forest with a mixture of coniferous and deciduous trees with three lakes nearby oriented in a northwest to southeast direction. Candle Lake was 17 km long and 12 km wide (at the widest) and was located approximately 1.5 km to the north. Torch Lake was 8 km long and 2.5 km wide and was located approximately 500 to 600 m to the west.

There was a nameless small body of water 3 km long and 700 m wide 250 m east of the release site.

In 1996, surface temperature and humidity were measured using a sling psychrometer, away from the Sun's radiation. Wind direction and speed were measured (not estimated) at a fixed point by an RM Young anemometer, approximately 4 m above the ground. Northerly wind direction and speed at Candle Lake may have been obstructed or altered by trees or the Sno-Drifters lodge.

Thompson Zoo

The instruments were housed on the mezzanine floor of the Thompson Zoo operations building. The release area was located at the south end of the zoo operations building. This area was flat and unobstructed to the south and east. Obstructions to release included the two-story zoo building to the north and electrical lines to the west. The observers had the opportunity to maneuver around these obstructions by releasing from the north side of the operations building. The receiving antennae were located on the roof of the operations building and as a result were unobstructed in all directions.

In 1996, surface temperature and humidity were measured using a sling psychrometer, away from the Sun's radiation. Wind direction and speed were measured (not estimated) at a fixed point by an RM Young anemometer, approximately 4 m above the ground. There were no major obstructions to the anemometer wind direction and speed.

Key Lake (BOREAS 1994)

The Vaisala Digicora II MW15 was located in an office in the terminal building at the Key Lake airport. The instruments associated with the READAC were located on a level, open sandy area with sparse grass cover at the Key Lake Mine airport. The instrument area consisted of a 90- x 90-m clearing in an old burn area. The clearing was surrounded by 2- to 3-m-tall jack pine.

The balloon inflation shed was southeast of the READAC instrument area near the airport terminal building. The surrounding countryside was jack pine forest with rolling hills and the occasional small lake.

Saskatoon (BOREAS 1994 and 1996)

The VIZ W9000 system and pressure sensor were located in the Saskatchewan Environmental Services Center (third floor) in Saskatoon. The instrument used to observe wind speed and direction was mounted on a tower on the roof of the building housing the weather services office (approximately 15 m above the ground).

The release site was within a baseball diamond located approximately 200 m from the VIZ system. The balloon inflation site was in a storage building next to the release site. Surface sling psychrometer observations were taken outside of the storage building. The release site was unobstructed.

Primrose Lake (BOREAS 1994)

Two different sites were used for release at Primrose Lake. Most of the balloons were released on top of a hill overlooking Primrose Lake to the northeast. Instrumentation used for surface observations was also situated on this hill. This location was higher than the rest of the terrain (approximately 100 m) and was covered by scrub brush and grasses. To the west of the release site was a forested area that consisted of small boreal forest tree cover. The release site was unobstructed.

The Pas, Lynn Lake and Churchill

No site descriptions are available.

The verification data measured at the surface were collected at the following sites:

BOREAS 1994:
Primrose Lake, Alberta (WIQ); Candle Lake, Saskatchewan (WLZ); Thompson Zoo, Manitoba (WTH); Saskatoon Weather Services Office, Saskatchewan (WXE); Key Lake, Saskatchewan (YKJ); The Pas, Manitoba (YQD); Lynn Lake, Manitoba (YYL); Churchill, Manitoba (YYQ).

BOREAS 1996:
Candle Lake, Saskatchewan (WLZ); Thompson Zoo, Manitoba (WTH); Saskatoon Weather Services Office, Saskatchewan (WXE); The Pas, Manitoba (YQD); Churchill, Manitoba (YYQ).

7.1.2 Spatial Coverage Map
Not available.

7.1.3 Spatial Resolution
The spatial resolution of the measurements is dependent on flight and atmospheric conditions.

7.1.4 Projection
Not applicable.

7.1.5 Grid Description
Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
The dates during which data were collected varied by station. The data collected in 1993 cover the period of 16-Aug to 20-Aug. The data collected in 1994, cover the period of 09-Apr to 19-Sep with intermittent gaps of a couple weeks. In 1996, the data cover the period of 08-Jul to 22-Oct.

7.2.2 Temporal Coverage Map
Not available.

7.2.3 Temporal Resolution
Sonde release times (generally) coincided with each other. During BOREAS 1994, the balloon release times were scheduled to follow the times determined by AES. The times of release (Greenwich Mean Time or 'Zulu') were intended to be at 15 minutes after the hours of 11:00, 13:00, 15:00, 17:00, 19:00, 21:00, and 23:00. The operators were allowed a window of time in which to make the release, spanning from 15 to 25 minutes after the hours specified above. However, these release times were not always the rule.

Thompson and Candle Lake released the most sondes (six or seven per day on most days and three per day otherwise), while the other sites were restricted to two or three releases per day.

During BOREAS 1996, Candle Lake and Thompson released radiosondes between 12 and 25 minutes after the hours of 11:00, 15:00, 17:00, 19:00, 21:00, and 23:00 (UTC) on fair-weather days and 11:00, 17:00, and 23:00 (UTC) on poor-weather days. Radiosondes at Saskatoon, The Pas, and Churchill were released between 12 and 25 minutes after the hours of 11:00 and 23:00.

During an ascent, the nominal time step between data points was :

1993:
Candle Lake - 1 sec.
Thompson - 1 sec.
Saskatoon - approx. 1.3 sec thermodynamics and 1 minute winds.
Lynn Lake - approx. 1.3 sec thermodynamics and 1 minute winds.
The Pas - no data.
Churchill - 10 sec.
Key Lake - 1 sec.
Primrose Lake - approx. 1.3 sec.

1994:
Candle Lake - 5 sec.
Thompson - 5 sec.
Saskatoon - approx. 1.3 sec thermodynamics and 1 minute winds.
Lynn Lake - approx. 1.3 sec thermodynamics and 1 minute winds.
The Pas - significant and mandatory level thermodynamics and 1 minute winds.
Churchill - 10 sec.
Key Lake - 10 sec.
Primrose Lake - approx. 1.3 sec.

1996:
Candle Lake - 2 sec
Thompson - 2 sec
Saskatoon - approx. 1.3 sec thermodynamics and 1 minute winds.
Lynn Lake - no data
The Pas - approx. 1.3 sec thermodynamics and 1 minute winds.
Churchill - 10 sec
Key Lake - no data
Primrose Lake - no data

7.3 Data Characteristics

7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

```
          Column Name
-------------------------------
SITE_NAME
SUB_SITE
DATE_OBS
TIME
GEOPTNTL_HEIGHT
ATMOSPHERIC_PRESS
AIR_TEMP
DEWPNT_TEMP
WIND_DIR
WIND_SPEED
U_COMPNT_WIND_VELOC
V_COMPNT_WIND_VELOC
POTNTL_TEMP
EQUIVALENT_POTNTL_TEMP
MIX_RATIO
REL_HUM
```

RADIOSONDE_RANGE
AZIMUTH
ELEVATION
LEVEL_TYPE
CRTFCN_CODE
REVISION_DATE

Note that for Vaisala data only (Candle Lake, Thompson, Key Lake, and Churchill), all variables related to humidity (DEWPTN_TEMP, POTNTL_TEMP, EQUIVALENT_POTNTL_TEMP, MIX_RATIO, REL_HUM) have been computed from a corrected RH (see Section 9.1 or 9.2.1, A).

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument, e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
TIME	The Greenwich Mean Time (GMT) when the data were collected.
GEOPTNTL_HEIGHT	The computed geopotential height above mean sea level.
ATMOSPHERIC_PRESS	The atmospheric pressure.
AIR_TEMP	The air temperature.
DEWPNT_TEMP	The dew point temperature.
WIND_DIR	The direction from which the wind travels.
WIND_SPEED	The speed of the wind.
U_COMPNT_WIND_VELOC	The westerly (from the west) vector component of the wind speed and wind direction.
V_COMPNT_WIND_VELOC	The southerly (from the south) vector component of the wind speed and wind direction.
POTNTL_TEMP	The potential temperature, estimated using the corrected relative humidity.
EQUIVALENT_POTNTL_TEMP	The equivalent potential temperature, estimated using the corrected relative humidity.
MIX_RATIO	The water vapor mixing ratio, estimated using the corrected relative humidity.
REL_HUM	The relative humidity of the air.
RADIOSONDE_RANGE	The horizontal distance of the radiosonde from the release point.
AZIMUTH	The azimuth direction of the radiosonde from the release point.

ELEVATION	The elevation of the site above mean sea level.
LEVEL_TYPE	Level-1 data: T or W or TW; defines a measured wind level (W), a measured thermodynamic level (T), or both a measured wind level and thermodynamic level (TW). For level-2 data: INT-T#W# is used where # is the number of levels of measured values used to interpolate the thermodynamic values or wind values, respectively.
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).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME	[HHMMSS GMT]
GEOPTNTL_HEIGHT	[meters]
ATMOSPHERIC_PRESS	[kiloPascals]
AIR_TEMP	[degrees Celsius]
DEWPNT_TEMP	[degrees Celsius]
WIND_DIR	[degrees true North in a clockwise direction]
WIND_SPEED	[meters][second^-1]
U_COMPNT_WIND_VELOC	[meters][second^-1]
V_COMPNT_WIND_VELOC	[meters][second^-1]
POTNTL_TEMP	[degrees Kelvin]
EQUIVALENT_POTNTL_TEMP	[degrees Kelvin]
MIX_RATIO	[grams of water vapor][kilogram dry air^-1]
REL_HUM	[percent]
RADIOSONDE_RANGE	[meters]
AZIMUTH	[degrees]
ELEVATION	[meters]
LEVEL_TYPE	[none]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

The data source for the parameters contained in the data files on the CD-ROM are:

Column Name	Data Source
SITE_NAME	[Assigned by BORIS]
SUB_SITE	[Assigned by BORIS]
DATE_OBS	[Supplied by ground system]
TIME	[Supplied by ground system]
GEOPTNTL_HEIGHT	[Interpolated to match fixed pressure levels]
ATMOSPHERIC_PRESS	[Interpolated to match fixed pressure levels]
AIR_TEMP	[Interpolated to match fixed pressure levels]
DEWPNT_TEMP	[Interpolated to match fixed pressure levels]
WIND_DIR	[Interpolated to match fixed pressure levels]
WIND_SPEED	[Interpolated to match fixed pressure levels]
U_COMPNT_WIND_VELOC	[Interpolated to match fixed pressure levels]
V_COMPNT_WIND_VELOC	[Interpolated to match fixed pressure levels]
POTNTL_TEMP	[Interpolated to match fixed pressure levels]
EQUIVALENT_POTNTL_TEMP	[Interpolated to match fixed pressure levels]
MIX_RATIO	[Interpolated to match fixed pressure levels]
CORRECTED_REL_HUM	[Interpolated to match fixed pressure levels]
REL_HUM	[Interpolated to match fixed pressure levels]
RADIOSONDE_RANGE	[Interpolated to match fixed pressure levels]
AZIMUTH	[Interpolated to match fixed pressure levels]
ELEVATION	[Interpolated to match fixed pressure levels]
LEVEL_TYPE	[Assigned during interpolation processing]
CRTFCN_CODE	[Assigned by BORIS]
REVISION_DATE	[Assigned by BORIS]

7.3.5 Data Range

The actual ranges for the various parameters were not determined due to the large amount of data in this data set.

7.4 Sample Data Record

The following a
re wrapped versions of a few records from a selected level-2 upper-air data file on the CD-ROM:

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME,GEOPTNTL_HEIGHT,ATMOSPHERIC_PRESS,AIR_TEMP,
DEWPNT_TEMP,WIND_DIR,WIND_SPEED,U_COMPNT_WIND_VELOC,V_COMPNT_WIND_VELOC,
POTNTL_TEMP,EQUIVALENT_POTNTL_TEMP,MIX_RATIO,REL_HUM,RADIOSONDE_RANGE,AZIMUTH,
ELEVATION,LEVEL_TYPE,CRTFCN_CODE,REVISION_DATE
'NSA-999-WTH02','AFM05-AES02',21-JUL-96,111500,206.0,98.2,9.0,9.0,-999,0.0,0.0,
0.0,283.61,304.05,7.35,100.0,-999.0,-999.0,-999.0,'Int-T2W2','CPI',05-MAR-97
'NSA-999-WTH02','AFM05-AES02',21-JUL-96,111502,222.95,98.0,9.85,7.21,180,1.3,
0.0,1.32,284.63,302.91,6.52,83.66,16.96,.06,86.18,'Int-T3W3','CPI',05-MAR-97
'NSA-999-WTH02','AFM05-AES02',21-JUL-96,111508,265.69,97.5,12.11,11.67,182,2.2,
.07,2.16,287.32,312.28,8.88,97.14,60.23,1.18,82.66,'Int-T4W4','CPI',05-MAR-97
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by BORIS is that from one radiosonde launch.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain ASCII 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.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

9.1.1 Derivation Techniques and Algorithms

Definition of terms (for below formulae):

T = temperature (deg. C)
P = pressure (mb)
RH = relative humidity (%)
MixRat = mixing ratio (g per kg)
Ts = saturation (LCL) temperature (K)
Ps = saturation (LCL) pressure (mb)
Tv = virtual temperature (K)
Theta = Potential temperature (K)
Rd = gas constant = 287.05 (J per kg per Kelvin)
G0 = acceleration due to gravity = 9.80665 (m/s^2)
ln = natural log
exp = exponential
TK = air temperature (K)

An evaluation of Vaisala RS80 radiosonde humidity sensor calibration showed a negative bias in humidity measurements. Three sets of humidity measurements were available to evaluate Vaisala RH: 1) M3 (laboratory calibration instrument) RH vs. Vaisala RH in controlled laboratory conditions, 2) routine prelaunch (station) surface temperature and dew point vs. prelaunch Vaisala RH, 3) Sling psychrometer temperature and dew point vs. Vaisala RH in the field. Analysis of all three data sets (with emphasis on laboratory tests) resulted in the following equations for Vaisala RH Correction (where h = Vaisala RH), expressed as a fraction of 0 to 1:

Bias1 = $-0.14286h + 0.10204h^2$ (utilized when Vaisala RH is < or = 90%)
Bias2 = $-0.4592 (1 - h)$ (utilized when Vaisala RH is > 90%)
Corrected RH = Vaisala RH - Bias

(These equations gave a maximum negative bias of -5% RH at 70% RH, and zero bias at 0% RH and 100% RH.)

Geopotential Height: is computed step by step as a cumulative sum of height differences between two different altitudes using the hydrostatic equation.

$$Z(2)-Z(1) = (Rd/G0)((Tv(2)+Tv(1))/2)*\ln(P(1)/P(2))$$

where: Virtual Temperature = $(T+273.16)*(1.0+Rd/0.62197)/(1.0+Rd)-273.16$

Mixing Ratio (Wexler):

$$622/((16.361/RH)*P*\exp(-17.67*T/(T+243.5))-1)$$

Potential Temperature (Theta): $(T+273.15)*(1000/P)^{(R/cp)}$

where: $R/cp = 0.2854*(1-0.28*MixRat/1000)$

Saturation (LCL) Temperature:

$$55+(2840/(3.5*\ln(Theta)-\ln(1000*MixRat/(622+MixRat))-4.805))$$

Saturation (LCL) Pressure: 1000*(Ts-Theta)^{3.4965}

Equivalent Potential Temperature (Bolton): Theta*exp(2.67*MixRat/Ts)

P, T, RH, U, V, Wdir, Wspd, Range, Azimuth and Elevation: measured by the upper-air system.

9.2 Data Processing Sequence

9.2.1 Processing Steps

Interpolation

AFM-05 personnel interpolated each sounding to regular 5-mb intervals where the values specify the mean pressure of that interval by layer averaging. For example, the 950-mb interval extends from 952.5 to 947.5 mb (i.e., 2.5 mb on either side of 950 mb).

The following variables were interpolated directly: elapsed time, geopotential height, temperature, dew point temperature, potential temperature, equivalent potential temperature, relative humidity, mixing ratio, the u and v wind speed components, and balloon position (in Cartesian coordinates). The following variables were estimated from the interpolated variables: wind speed and direction (computed from interpolated u and v) and range, azimuth, and elevation (computed from interpolated balloon position).

Please note that the derived thermodynamic variables (potential temperature, equivalent potential temperature, and mixing ratio) were not recalculated from the 5-mb averages of the measured thermodynamic variables (temperature and relative humidity). Instead, the derived thermodynamic variables were interpolated directly. In most cases, the two values will be only subtly different.

Interpolation used layer averaging, as follows. Let's consider the 5-mb interval at 950 mb, which extends from 952.5 to 947.5 mb. (1) We identified the measured data within the 5-mb subinterval. We will denote the number of points as n. (2) We estimated the data values at the interval's two endpoints (e.g., at 952.5 and 947.5 mb), by linear interpolation of measured data. (3) We divided each 5-mb interval (with n measured data points and two interpolated endpoints) into (n+1) subintervals. (4) For each of the (n+1) subintervals, we calculated the subinterval mean (the average of its two endpoints), and the subinterval size (P(2)-P(1)). (5) The layer average was then calculated as an average of the n+1 subinterval means, weighted by the subinterval size.

Here is an example for Temperature in Kelvins (TK) where n = 2. The values marked "**" are the interpolated interval endpoints.

Measured P (mb): 953.0, 951.0, 948.0, 946.0
Measured T (K): 300.0, 300.8, 300.8, 300.0
Subinterval P (mb): 952.5**, 951.0, 948.0, 947.5**
Subinterval T (K): 300.2**, 300.8, 300.8, 300.6**
P(2)-P(1): 1.5, 3.0, 0.5
0.5*(TK(1)+TK(2)): 300.5, 300.8, 300.7

TKLayerAvg = Sum from i=1 to n+1 [(0.5*(TK(i)+TK(i+1)) * (P(i)-P(i+1))) / (5mb)]

Each interpolated data line includes information in the LEVEL_TYPE field showing the number of raw thermodynamic and wind levels within that 5-mb interval used to average that layer. For example, a LEVEL_TYPE value of Int-T5W3 means that 5 thermodynamic levels and 3 wind levels were available within that 5-mb interval. If there were no raw data within that 5-mb interval, the LEVEL_TYPE will indicate that 0 levels (i.e., Int-T0W0) were available for interpolation of that layer. If the raw data gap was greater than 100 mb, the variables were not interpolated and were shown to be missing (-9999.00).

Note that for Vaisala sites (Candle Lake, Thompson, Churchill, and Key Lake), the original RH is not available in the interpolated files. Instead, the corrected RH, along with the variables that were derived from this corrected RH (Td, Theta, ThetaE, MixRat), is available.

After loading the data into the relational data base, BORIS personnel converted the pressure values to units of kiloPascals for consistency with other pressure measurements.

9.2.2 Processing Changes

None given.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

Corrections/adjustments have been made for:

1) RH (Vaisala, all flights)
2) Elevation and surface pressure (Saskatoon, 1994 flights only)
3) Increasing pressure (A.I.R., Primrose Lake)
4) Some surface observations when required.

See Section 9.2.1 for more information.

9.3.2 Calculated Variables

zGeoPot, Td, Td_c, Theta, Theta_c, ThetaE, ThetaE_c, MixRat, MixRat_c, RH_c. See Section 9.1.1 for more information on these variables.

9.4 Graphs and Plots

None given.

10. Errors

10.1 Sources of Error

Surface Observations

Surface observations were not investigated at The Pas and Churchill for BOREAS 1996 (see Section 5 for more information):

Ordinary Thermometers

(housed in Stevenson screens during 1994 at Primrose Lake, Candle Lake, and Thompson):

Dust or moisture on the instrument could affect the temperature. Human error or a break in the mercury column could also have resulted in an incorrect observation. Wet bulb temperature could have been incorrect if the wick or sleeve had dried out. A dirty or fallen wick/sleeve could have resulted in an error. Also, the observer should have applied the required correction factor for each thermometer and used the psychrometric tables properly to determine the relative humidity.

READAC at Key Lake (1994) could have given improper readings if the temperature probe or dew cell was dirty. Moisture inside the dew cell containment could also have resulted in erroneous data.

Wind may have been observed improperly by automated sensors if they were defective (i.e., worn bearings). Incorrect observations may have resulted if the dials on the sensor were not properly adjusted.

Many problems are associated with estimating wind speed and direction (i.e., at Candle Lake in 1994). Location, improper timing of 2-minute average, gusts, etc., are some of the perceived problems.

Sling Psychrometers

(Candle Lake and Thompson - 1996, also Saskatoon - 1994 and 1996):

Radiation errors may have resulted if the instrument was not shaded properly. If the instrument was not rotated for more than 1 minute, the temperature may not have stabilized. However, if the instrument was rotated too much, the wet bulb sleeve may have dried out, resulting in a humidity measurement that was too high. Other sources of error include improper readings, a dirty sleeve, or a break in the mercury column.

Pressure from the Barometers

(Candle Lake and Thompson (1996):

Errors could have resulted from improper readings or incorrect calibration.

Wind direction and Speed (1996):

Northerly winds at Candle Lake may have been subject to errors due to obstructions by trees and buildings; however, the anemometer at Thompson was unobstructed in all directions.

Upper Air:

Possible sources of error associated with radiosondes include: Improper handling (touching the sensors, dropping the instrument), improper storage (too warm or cold), balloon defects (such as leaks, weak spots), improper balloon inflation (over- or under-inflation), dirty instruments, and radiosonde not equilibrated with the outside atmosphere for the required duration.

10.2 Quality Assessment

10.2.1 Data Validation by Source

Graphs and plots have been produced to flag obvious problems in pressure, temperature, humidity, and winds. Any problems were noted.

Computed variables (such as potential temperature, mixing ratio, and pressure height) have been scrutinized by comparing different versions of formulae used to compute these variables.

Processed variables have been compared with the raw data to ensure that no significant changes have occurred. Any discrepancies have been noted and fixes made. If errors stemmed from the raw data file, the problems were noted and corrections made if necessary.

10.2.2 Confidence Level/Accuracy Judgment

The upper-air data, for the most part, are reliable and few soundings were rejected.

- Vaisala: Measured RH and temperature with precision, and in particular, gave reliable RH measurements below 20% RH. However, the accuracy of wind data was sometimes questionable between the surface and 1-2 km geopotential height. Some Vaisala flights also had high oscillations in wind direction and speed throughout the flight, especially at the most northerly site, Churchill.
- VIZ W9000: Measured humidity and temperature at high resolution but only produced 1- or 2-minute wind direction and speed.
- A.I.R.: Measured both thermodynamic and wind data at high resolution. Minimal data filtering was performed by these systems well, but few problems were found with both thermodynamic and wind data.
- ADRES: Due to the nature of these data (significant and mandatory thermodynamic levels), their accuracy relied primarily on the system operator. Few problems were encountered with both thermodynamic and wind data provided by this system.

10.2.3 Measurement Error for Parameters

See Section 4.1 for instrument precision.

10.2.4 Additional Quality Assessments

Not applicable.

10.2.5 Data Verification by Data Center

BORIS personnel reviewed the data for consistency and format. In addition, the values from randomly selected flights were plotted and viewed for any seemingly abnormal values.

11. Notes

11.1 Limitations of the Data

None given.

11.2 Known Problems with the Data

- Ekman spirals found in Vaisala wind data (usually below 3 km geopotential height).
- Missing wind data at the start of 1994 IFC 1 until 6 June 15Z at Thompson Zoo due to an equipment failure.
- Some full resolution flight data near the end of IFC-1 (1994) at Saskatoon was accidentally overwritten. These data have been replaced with significant level data.
- Many flights from Candle Lake for the 1996 Fall IFC, terminated prematurely. The cause was not determined.

11.3 Usage Guidance

- Be aware that different systems produce slightly different measurements at different temporal resolutions.
- The upper-air data has been manipulated by various computer programs, all of which have been scrutinized carefully, but there is still some chance of human error.
- Be aware that Vaisala RH and all other humidity variables have been corrected based on field and lab tests. The user is recommended to use this corrected data, but the original Vaisala RH is available as well.

- Be aware that the Vaisala system performed data filtering and gap filling on both wind and thermodynamic data. The other upper-air systems provided less quality control than Vaisala.

11.4 Other Relevant Information

None given.

12. Application of the Data Set

The data can be used for monitoring the development of the boundary layer and atmospheric movement and condition during the ascents. In addition, the data can be used for comparisons with field studies occurring during respective IFCs.

13. Future Modifications and Plans

None given.

14. Software

14.1 Software Description

The software used to process BOREAS upper-air data was developed within AES and consisted of a number of different programs written in C++ and QuickBasic. The software was capable of converting the original flight files, which were usually in binary format, to ASCII text. Following this conversion, certain variables were computed and/or interpolated, then the files were put into a common format. See Sections 9.1 and 9.2 for more information.

14.2 Software Access

The software used to process BOREAS data can be accessed through:

Alan Barr or Geoff Strong
National Hydrology Research Centre
11 Innovation Blvd.
Saskatoon, SK
S7N 3H5
Canada

15. Data Access

The level-2 upper-air network standard pressure level data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

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

15.2 Data Center Identification

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

15.3 Procedures for Obtaining Data

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

15.4 Data Center Status/Plans

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

16. Output Products and Availability

16.1 Tape Products

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

Atmospheric Instrumentation Research, Inc., Automatic Radiotheodolite Model AIR-3A-RT (Brochure).

Atmospheric Instrumentation Research, Inc., Intellisonde Digital Radiosonde IS-4A Series (Brochure).

Atmospheric Instrumentation Research, Inc., RAWIN Upper-Air Sounding Systems (Brochure).

Vaisala, 1993, UAD Technical Manual.

VIZ Meteorological Instruments, VIZ-BEUKERS LO-CATE MICROSONDE(Brochure).

17.2 Journal Articles and Study Reports

Atmospheric Environment Service. 1994. Inspection Reports.

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Beukers, J.M. and M. Friedman. 1981. A Digital Radiosonde For Automated Observations In the 1980's. Beuker's Laboratories, Inc., St. James, NY.

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.

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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.

Strong, G.S., A.G. Barr, and C.L. Hrynkiw. 1996. Intercomparisons of the Vaisala and Airsonde Sounding Systems During BOREAS. CMOS Bulletin, June 1996.

17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

A.I.R.	- Atmospheric Instrumentation Research, Inc.
ADRES	- Aerological and Data Reduction System
AES	- Atmospheric Environment Service
AFM	- Aircraft Fluxes and Meteorology
ASCII	- American Standard Code for Information Interchange
BOREAS	- BOReal Ecosystem-Atmosphere Study
BORIS	- BOREAS Information System
CANDL	- Candle Lake
CD-ROM	- Compact Disk-Read-Only memory
CHURCH	- Churchill
DAAC	- Distributed Active Archive Center
EOS	- Earth Observing System
EOSDIS	- EOS Data and Information System
GIS	- Geographic Information System
GMT	- Greenwich Mean Time
GSFC	- Goddard Space Flight Center
HTML	- HyperText Markup Language
IFC	- Intensive Field Campaign
KEY	- Key Lake
LYNNL	- Lynn Lake
NAD83	- North American Datum of 1983
NASA	- National Aeronautics and Space Administration
NSA	- Northern Study Area
NSBF	- National Scientific Balloon Facility
ORNL	- Oak Ridge National Laboratory
PANP	- Prince Albert national Park
PRIMR	- Primrose Lake
ROM	- Read-Only memory
SSA	- Southern Study Area
STOON	- Saskatoon
THEPAS	- The Pas
THOMP	- Thompson
URL	- Uniform Resource Locator
UTC	- Universal Time Code
WIQ	- Primrose Lake, Alberta
WLZ	- Candle Lake, Saskatchewan
WTH	- Thompson Zoo, Saskatchewan
WXE	- Saskatoon, Saskatchewan
YKJ	- Key Lake, Saskatchewan
YQD	- The Pas, Manitoba
YYL	- Lynn Lake, Manitoba
YYQ	- Churchill, Manitoba
Z	- Zulu Time (equivalent to Greenwich Mean Time)

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13. ABSTRACT *(Maximum 200 words)*

The BOREAS AFM-5 team collected and processed data from the numerous radiosonde flights during the project. The goals of the AFM-05 team were to provide large-scale definition of the atmosphere by supplementing the existing AES aerological network, both temporally and spatially. This data set includes basic upper-air parameters interpolated at 0.5 kiloPascal increments of atmospheric pressure from data collected from the network of upper-air stations during the 1993, 1994, and 1996 field campaigns over the entire study region. The data are contained in tabular ASCII files.

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